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Large Roller-Crest Dam, Grand Valley Project, Colorado

By F. Teichman*

SYNOPSIS—Details of design of largest steel roller-crest dam in the United States, just completed over the Grand River in Colorado, on the Grand Valley project of the United States Reclamation Service.

The Grand River leaves its mountainous confines at Palisade, Colo., and there enters upon a large tract of valuable fruit land, the commercial center of which is the town of Grand Junction, Colo. A large part of this valley has been under irrigation for many years through the canals of different private companies. The Orchard Mesa District is a picturesque elevated irrigated bench lying on the left bank of the river, the water for the irrigation of which is taken from the river at the Orchard Mesa dam, a wicket diversion dam about 7 mi. up river from Palisade and the farthest upstream of the various irrigation structures on the river. About half a mile downstream from this dam the Grand River project of the United States Reclamation Service has its intake structure and diverts at this point 1,425 sec.-ft. for the irrigation of 53,000 acres of good farming land lying to the right of the river and higher than the land heretofore reached by irrigation, constituting a body of land 1½ to 4 mi. wide and 27 mi. long. The diversion dam and intake structure are interesting to the engineer and form a pleasing and impressive structure that attracts the eye of the traveler on the Denver & Rio Grande R.R. by the charm of its contrast with the rugged lines of the surrounding mountain scenery.

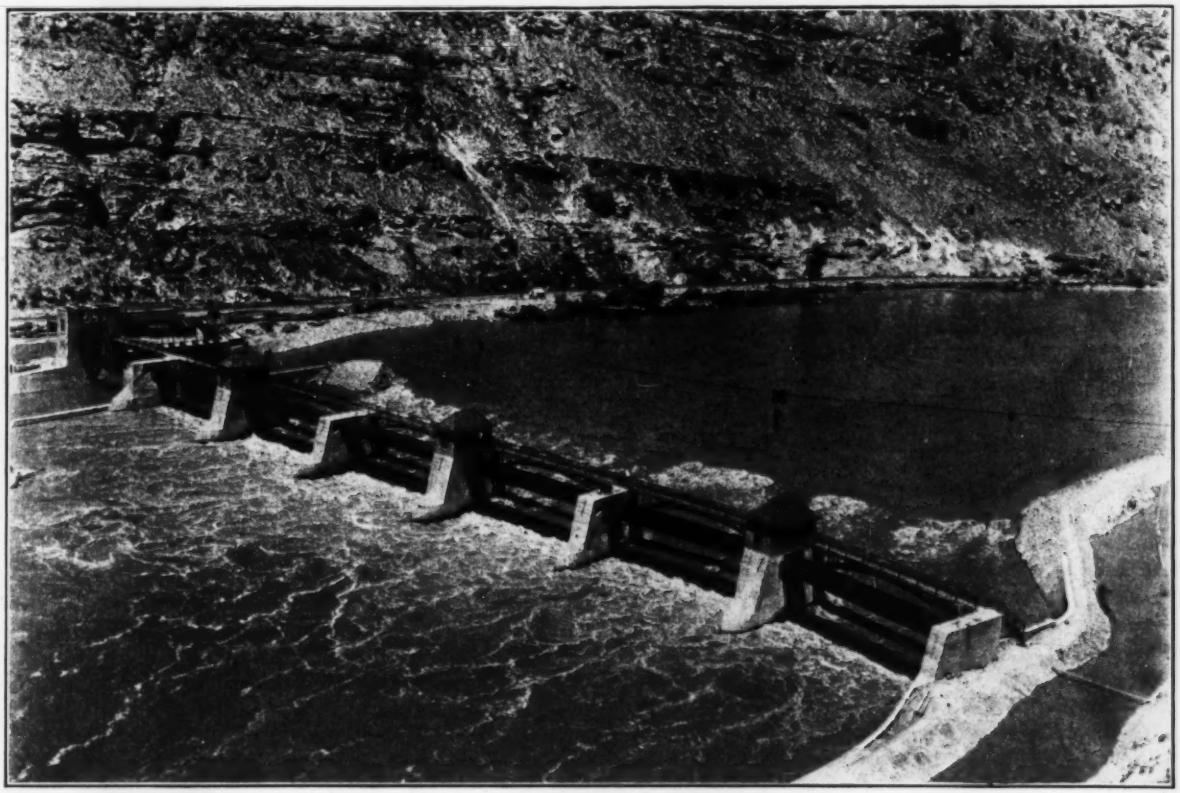

FIG. 1. VIEW OF COMPLETED ROLLER-CREST DAM ACROSS GRAND RIVER

The problem in the design of the diversion dam was to raise the level of the water in the river at times of low flow sufficiently to send 1,425 sec.-ft. into the intake

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and yet at times of flood to permit the maximum flow (estimated at 50,000 sec.-ft.) to pass the dam without raising the water level upstream to a plane where the adjacent roadbed of the Denver & Rio Grande R.R. (elevation of base of rail 4,797) would be endangered. The solution developed consists of a concrete weir of an elevation sufficiently low to allow the estimated maximum flood to pass with safety, superimposed upon which is a movable steel roller crest providing the additional elevation required for ordinary diversion purposes.

The movable steel crest over the Grand River has an aggregate net length of 480 ft., divided by six piers into seven spans, one clear span of 60 ft. near the right bank of the river and six clear spans of 70 ft. each. The 60-ft. span is across the sluiceway in front of the intake openings of the Government canal, and its movable crest is 15 ft. 4 in. high; the six 70-ft. crests are 10 ft. 3 in. high. The sill elevation of the 60-ft. opening is 4,777 and of the 70-ft. openings 4,782, thus making the spill level of the movable crest at El. 4,792.25. The sluiceway has an inclined concrete floor sloping from El. 4,779 at upstream end to El. 4,777 at the dam. The elevation of the sill of the intake gates is 4,785.25—that is, about 7½ ft. above the floor of the sluiceway. There are nine intake openings of 7x7 ft. Where the dam terminates at the left bank of the river, provision is made by four gates 7 ft. wide, 5 ft. high and of sill elevation 4,787.25 to supply the Orchard Mesa canal at this place instead of at the old Orchard Mesa dam previously mentioned.

Among the advantages of the dam as designed are the following: The dam is laid square across the river and

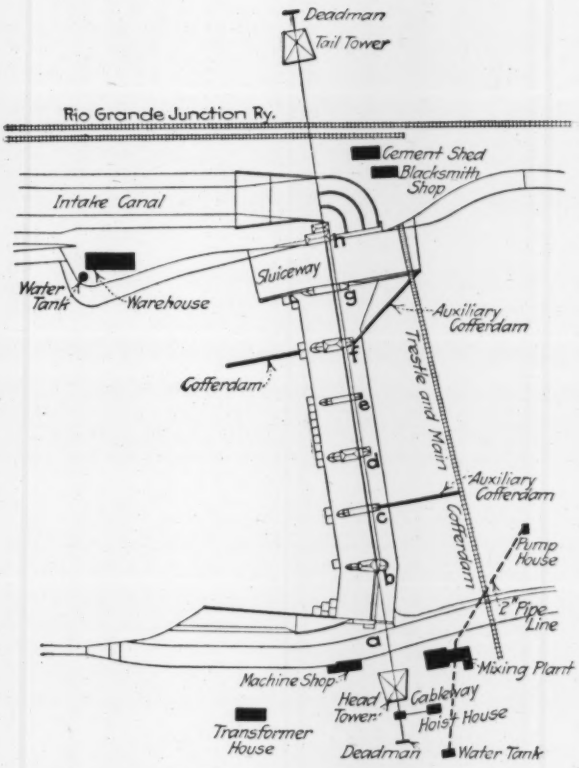


FIG. 2. GENERAL LAYOUT OF GRAND VALLEY DIVERSION DAM

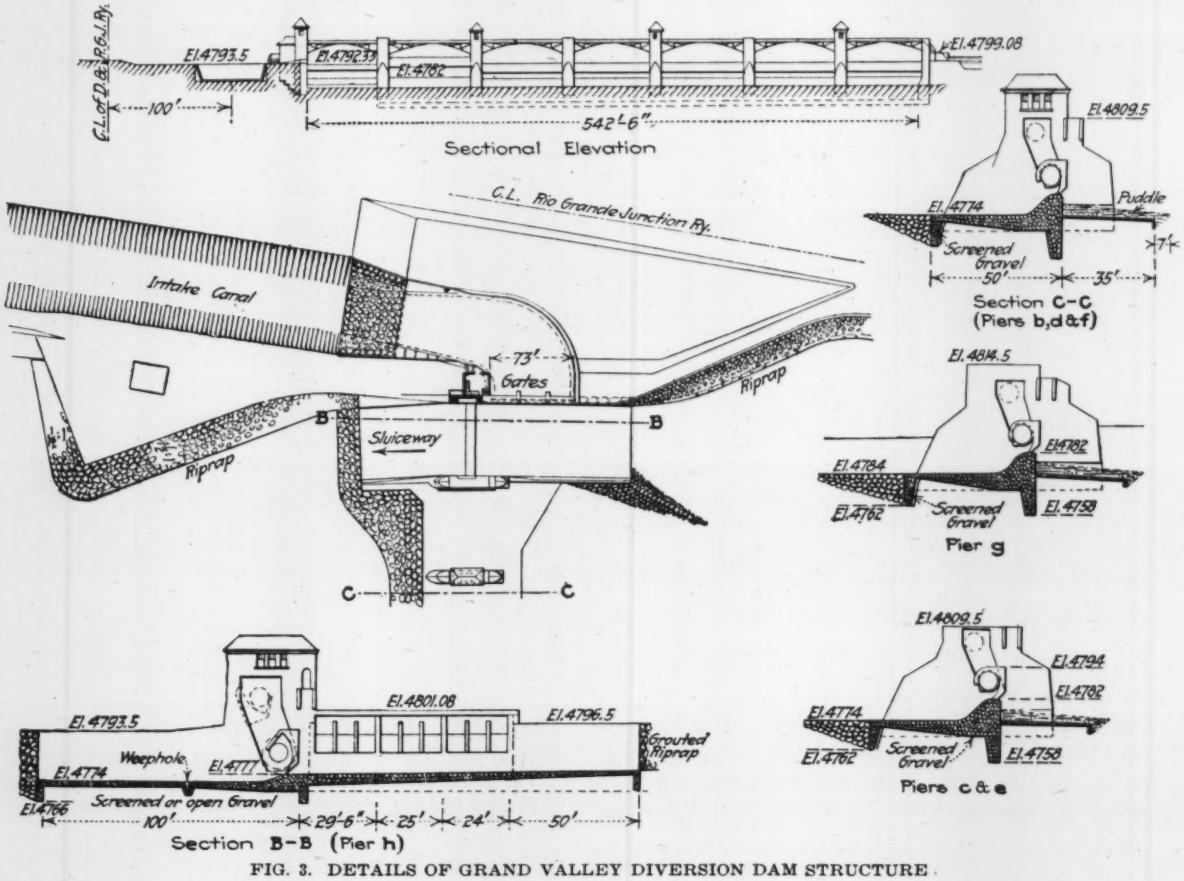


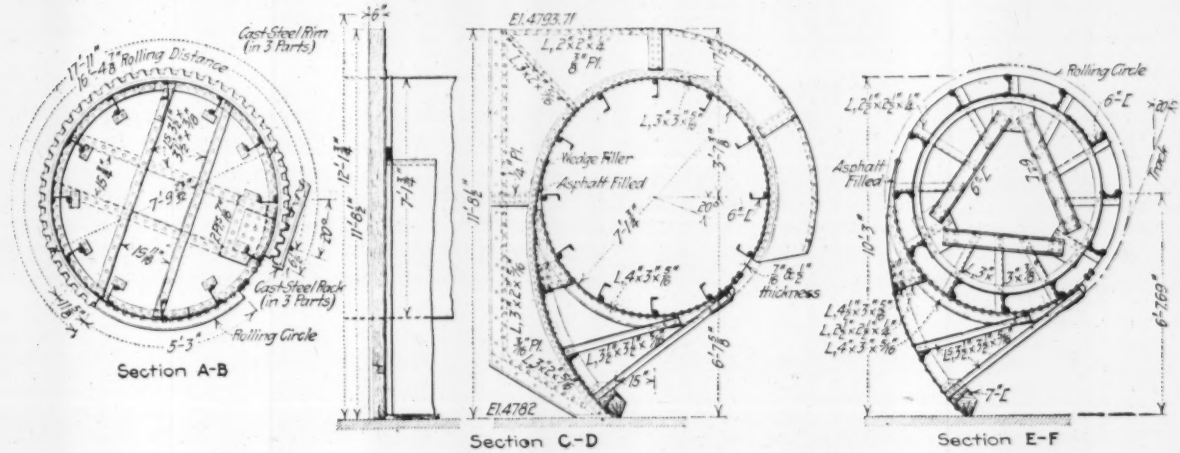
FIG. 3. DETAILS OF GRAND VALLEY DIVERSION DAM STRUCTURE

is made as long as possible in order to reduce the necessary height of the movable steel crest and to reduce also the cost of the work required to safeguard the left bank where the Orchard Mesa canal lies close to the rock cliff. The openings between piers are large enough and the movable crest can be raised high enough so that the lodging of floating trees at time of flood is precluded. The flow into the intakes on either side of the river is normal to the flow of the river, so that there will be little interference from drift; and the sill of the intake gates is sufficiently high above the floor of the sluiceway, at the right bank, to let the heavier silt pass by the gates below the level of the sill. Any silt deposit formed between the floor of the sluiceway of the Government intake and the sill of the gates can be washed downstream by opening at intervals the 60-ft. wide movable crest. (No special sluiceway is arranged for the intake of the Orchard Mesa canal.)

The scouring effect of the water with the sluiceway open is vigorous, and the sluiceway is freed from deposit in a short time and with a small expenditure of water.

The roller-crest dam consists of a horizontally disposed sheet steel hollow cylinder running on smooth tracks set in recesses in the piers and provided with cog rims which, engaging with racks set alongside the smooth tracks, insure a rotary motion of the cylinder as it is raised. The central cylinder is provided with an extension shield held on tangentially disposed struts. This shield when the dam is lowered comes to a bearing on the concrete sill, thus forming the bottom seal. The end seals are flexible steel shields lined at their upstream edges with timbers that are made to fit a slightly inclined plane on the face of the pier. By this arrangement the water pressure keeps the end shields tight against the piers and there will be clearance between these timbers and the pier faces as soon as the roller has risen a few feet. Fig. 1 shows the structure as a whole and Fig. 4 gives the main details of the steel work framing of the 70-ft. section.

In determining the outline of the curved shields two points were considered: (1) That the elements of the shield when the roller first rises should draw away from (not enter into) any silt deposit that may have formed in front of the shield, and (2) that the water pressure against the shield for the initial positions of the rising roller (where the resistance of silt on the curved shield and the friction of the end shields is the greatest and where the moment of the weight of the shields is great) should be such as to require no greater chain pull for



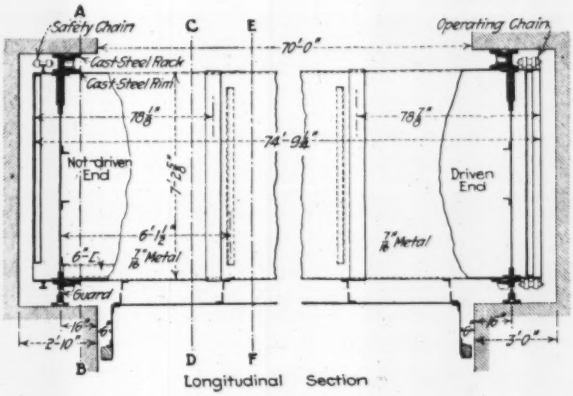


FIG. 4. DETAILS OF A 70-FT. ROLLER CREST ON GRAND VALLEY DAM

The roller-crest dam consists of a horizontally disposed sheet steel hollow cylinder running on smooth tracks set in recesses in the piers and provided with cog rims which, engaging with racks set alongside the smooth tracks, insure a rotary motion of the cylinder as it is raised. The central cylinder is provided with an extension shield held on tangentially disposed struts. This shield when the dam is lowered comes to a bearing on the concrete sill, thus forming the bottom seal. The end seals are flexible steel shields lined at their upstream edges with timbers that are made to fit a slightly inclined plane on the face of the pier. By this arrangement the water pressure keeps the end shields tight against the piers and there will be clearance between these timbers and the pier faces as soon as the roller has risen a few feet. Fig. 1 shows the structure as a whole and Fig. 4 gives the main details of the steel work framing of the 70-ft. section.

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All the elements of the curved shields receive, in the lowest position of the roller, water pressures the moment of which tends to raise the roller; and all these elements have, when the roller begins to rise, a direction of motion which forms an angle with the tangent of that element. This angle indicates the degree of retrogression of the element from the silt in front of it, the degree of retrogression being larger for the lower elements of the shield where the silt effect is the greatest. As the roller rises, the angle of retrogression diminishes for all the elements of the shield, becomes zero and then reverses into an angle of progression, the angle of retrogression being longer retained as such for the lower element of the shield than for the upper. The reversal from retrogression to progression takes place only after the roller has risen high enough to permit the water to break through under the roller and wash out the silt deposit or keep it in agitation.

There is a stationary smooth track on the piers at an inclination of 20° to the vertical and a circular smooth rim on the drum, the latter rolling on the former as the roller moves up or down.

As the drawings show, the track is cast as one piece with a rack, and the smooth rim is cast as one piece with a gear segment. Rack and gear are in mesh, thus precluding a sliding motion of the rim on the track.

Parallel to the track, near the diametrically opposite side of the rim, there is a guard compelling the meshing of rim and rack teeth. One end of the roller has wrapped around it the operating chain, which unwinds as the roller rises and is taken up by an eight-tooth sprocket wheel forged as one piece with a heavy shaft. This shaft is placed on steel girders high enough above the rollers to clear them in their highest position and is actuated by gearing, wormwheel and worm, and electric motor.

A rolling crest of similar design is provided by the Washington Water Power Co. for the crest of the spillway of Long Lake, near Spokane (see *Engineering News*, Sept. 19, 1914), there being three rollers of 65 ft. span and 19 ft. height. The United States Reclamation Service has installed a small rolling crest 30x8 ft. in connection with the Boise project. The Grand River rolling crest seems to be the third installation of this kind of dam in this country.

Numerous dams of the rolling-crest type have been built in Europe. One remarkable instance is the dam at Kibling, Germany, which has one roller of 46 ft. clear span by 28 ft. height. Another interesting instance is that of a dam near Stuttgart, Germany, having two spans of 92 ft. by 12 ft. height. The contract for their manufacture and installation required a leakage of less than 0.53 sec.-ft. per span. Tests after erection established a leakage of less than 0.5 sec.-ft. for both spans together.

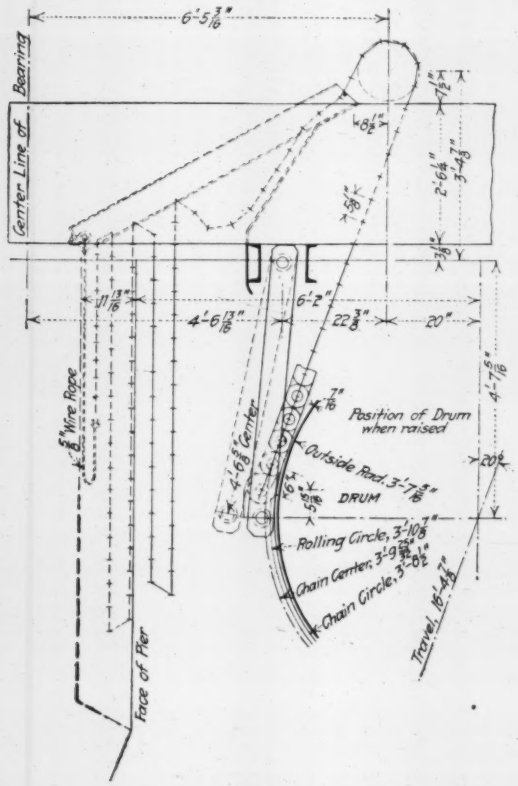

FIG. 5. HOW THE ROLLER CREST MOVES

Fig. 6 shows the 60-ft. sluiceway with roller down on sill, and the face wall of the intake structure with its nine 7x7-ft. gates. This photograph was taken before the completion of the operating house and the placing of the winch for the 60-ft. roller. The construction of the intake gates is in the form of a light cast-iron arch with occasional ribs and with three pairs of angle-irons riveted to the gate body as chords to take the arch thrust. A straight wooden sill is attached to the gate. The part of the gate body projecting upstream from the sill is attached to the gate. The part of the gate body projecting upstream from the sill (in plan) contributes sufficient buoyancy to the gate to practically balance its weight when the gate is submerged. All gates are operated by means of one line shaft and connection is made with any individual gate by placing into mesh the line shaft bevel pinion of that individual gate stand with its bevel gear.

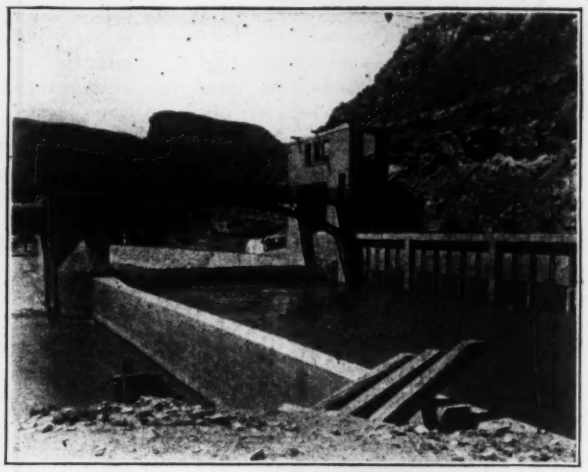

FIG. 6. SLUICEWAY WITH 60-FT. ROLLER CREST DOWN

A ½-in. wire cable weighted at either end passes by all gate stands at level of floor and at each gate stand is wound over a 10-in. wheel which carries also a socket for a hand lever. The rope leads into the engine house and there actuates the cones of a duplex friction clutch so that the line shaft may be rotated either one way or the other. Preparatory to any gate operation the attendant places in mesh the pinion of such gate or gates as he wishes to raise or lower, he starts the motor and inserts his hand-lever in the socket of one of the 10-in. wheels conveniently located to watch the motion of the gates. Pressing the lever upstream raises the gates, downstream lowers the gates. Without pressure on hand-lever the gate motion will stop due to the steepness of the cone of friction clutch.

The Grand River project is one of the enterprises of the United States Reclamation Service, A. P. Davis, Chief Engineer. R. F. Walter has been until lately the supervising engineer of this district and J. H. Miner is the project manager of the Grand River project. The general design of the diversion dam as a whole was made by the writer in coöperation with the engineers mentioned, aided by the advice of D. C. Henny, Consulting Engineer. The dam was built under the direction of O. T. Reedy, Construction Engineer, who together with the project manager also designed the piers and foot bridge, which give a monumental appearance. The intake structures and the steel structures of the rolling crest were also designed in detail by the writer, following, as to the rolling crest, the lines laid down in a general way by the German patentees of this kind of movable dam. The Riter-Conley Manufacturing Co., Pittsburgh, Penn., was the contractor for the fabrication of the rolling crest.

State Engineer's River Survey Guides Water Adjudicators

By Percy A. Cupper*

The uncertainty of property rights to the use of water in the Western states has led many of these states to enact "water codes." These statutes serve three distinct purposes: (1) The determination of existing water rights; (2) providing a definite record for all new water rights; and (3) the distribution of the water to those entitled to it.

The determination of water rights necessarily involves many judicial questions that, prior to the adoption of the water codes in the various states, were passed upon by the courts. Lack of physical and engineering data in most cases and the lack of due appreciation of their worth and their application and relation to the legal questions involved have led the courts into many grievous errors and have caused some ridiculous findings. One learned jurist in reviewing such a decision poured forth his wit and sarcasm and garnished the somber pages of legal lore with the following literary gem:

> Heroically setting aside the statute, the decisions and the evidence in the case, he assumes the role of Jupiter Pluvius, and distributes the waters of Goosberry Creek with a beneficent recklessness which makes the most successful efforts of all the rain wizards shrink into insignificance, and which would make the hearts of the ranchers on Goosberry dance with joy if only the judicial decree could be supplemented with a little more moisture. The individual who causes two blades of grass to grow where but one grew before is held in highest esteem as a benefactor of his race. How then shall we rank him who, by judicial fiat alone, can cause 400 in. of water to run where nature only put 100 in.? We veil our faces, we bow our heads before this assumption of judicial power and authority. . . . Evidently the court assumed that Goosberry Creek was as inexhaustible as the widow's cruse, or else that its decree possessed the potency of Moses' rod. (3 Ida. 255, 28 Pac. 438, Hillman vs. Hardwick.)

To avoid such mistakes on the part of the state water board, the Oregon water code, like most similar statutes, wisely requires the state engineer to make surveys and investigations as a guide to the board in its findings.

It was no easy matter at the outset to determine what information would be required in the determination of water rights. It was only after five years' experience on the various streams of the state that the plan followed on the Wallowa River survey was rounded out.

Wallowa River Conditions

Wallowa River rises in the high granite peaks of a spur of the Blue Mountains, and after flowing through a steep timbered area it widens in Wallowa Lake, of terminal moraine formation. Wallowa Lake is used for a storage basin, and water is diverted directly from the lake for municipal supply. Immediately below the lake the water is diverted for power development and the irrigation of land in what is known as the Upper Valley. The stream flows through, and together with its tributaries serves to irrigate the agricultural land in Lostine and Wallowa Valleys and furnishes water for power development, municipal and domestic supply.

To determine the legal rights requires collecting many engineering data and making a careful analysis of them. Granting to one appropriator slightly more water than he is entitled to may deprive a subsequent appropriator of water upon which he is relying to irrigate a well-improved farm. Again, while two appropriators may appear to tap the same source of supply, the lower appropriator may be fed by return seepage or springs; and to divide the flow at the upper point of diversion between the two would really deprive the upper appropriator and give to his neighbor an excess supply. The amount of land irrigated, power developed or water used for municipal supply are matters upon which the testimony of the ordinary witness throws but little light.

Beneficial use is the basis, the measure and the limit of a water right; hence not the amount of water a man uses, but the amount he beneficially uses, is the quantity he is entitled to. In order to establish these facts a survey of the irrigated land is made, the ditches and streams are measured, and variation tests are carried on to determine the proper duty of water.

Making Surveys and Stream Gagings

The survey of Wallowa River was commenced in August, 1914, and completed in September, 1914, while the stream measurements were begun in 1914 and carried through the irrigation season of 1915. The variation tests were made during 1915. A plane-table survey was made showing all irrigated land, streams, ditches, pipe lines, power plants, waterwheels, etc. The maps were made on a scale of 2 in. = 1 mi., though a scale of 4 in. = 1 mi. was adopted where it was necessary to show a great deal of detail. Elevations were not carried except for short distances along the ditches, to ascertain the grade and in determining the storage capacity of the lake. Compass control was employed, with a check on every section corner or property line that could be located. Plane-tables 18x20 in. were used, each sheet covering a township. The survey shows 39,000 acres of irrigated land. Present-ownership plats on a scale of 2 in. = 1 mi. were prepared for the county records.

Two gaging stations had been maintained on the stream for several years, and some records were available of the fluctuations of the lake surface; some of the larger ditches had also been measured. However, when the investigation in connection with the adjudication of water rights was commenced, gaging stations were established on all the important ditches and streams. These stations were rated by means of a current meter, and at most of the stations daily gage readings were taken. Weirs were established to measure the water applied in the variation tests and in a few instances to measure the water applied in the irrigation of a well-defined tract. The variation tests were made on three tracts seeded to alfalfa, oats and barley.

Water Supply of Three Valleys Found Independent

After the field work was completed and the data were assembled, a careful analysis of the results was made. The report prepared from this shows clearly that the water-supply for the three valleys through which the Wallowa River flows may be considered independently. The importance of this conclusion for the purpose in hand can hardly be over-estimated. Had the determination of the water rights on this stream been taken up without such an investigation, it would probably have been concluded that the water-supply flowing out of the lake had been distributed more or less over the entire area irrigated from the main stream. While this is true to a limited extent, the report shows that that part of the regular flow of the stream which is used for the irri-

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gation of land in the two lower valleys is return seepage and that the diversion and use of the entire stream near the outlet of the lake do not affect the rights below.

The report takes up in detail the flow of water through each of the ditches upon which gaging stations were established, and by means of hydrographs shows the discharge through the ditch for every day during the irrigation season and also the head in miner's inches per acre that was used. For example, in discussing one of the larger ditches diverting water near the outlet of the lake the report gives the following:

> Average head flowing in this ditch from July 15 to July 31 inclusive, 1905, was 52.6 sec.-ft., or 0.64 miner's inch per acre. The average flow during August, 1905, was 17.3 sec.-ft., or 0.21 miner's inch. The maximum head diverted during 1905, as shown by the records, was 86 sec.-ft., or 1.05 miner's inches per acre. The average head diverted through this ditch in June, 1906, was 49.3 sec.-ft., or 0.61 miner's inch per acre; and during July, 1906, the average head was 54.9 sec.-ft., or 0.69 miner's inch per acre for the area of 3,251 acres. The maximum head diverted during the season 1906, up to Aug. 1, was 74 sec.-ft., or 0.94 miner's inch per acre, for the above area.
>
> . . . . . .
>
> The records of the flow of this ditch during 1915 represent the amount of water diverted for use, the gage station being above all irrigated lands and below all waste gates. The average flow of water in the ditch from June 7, water being turned in on or about this date, to June 30 inclusive, 1915, was 78.4 sec.-ft., or 0.96 miner's inch per acre. During July, 1915, the average head was 60.8 sec.-ft., or 0.75 miner's inch per acre; and during August the average head was 14.8 sec.-ft., or 0.18 miner's inch per acre. The maximum head diverted during the season of 1915 was 103 sec.-ft., or 1.36 miner's inches per acre, which head was only maintained for one day. The amount of water diverted through this ditch from June 7 to Aug. 21 inclusive, 1915, was 2.49 acre-feet per acre for the area affected.

A comparison of the climatic conditions prevailing during 1915 with those of other years, as shown by the Weather Bureau station records, was made. By this means the amount of water available and the amount required were compared with the amount available and the amount required during other years.

The variation tests were carried on so as to secure practical rather than theoretical results. A tract was selected and divided into three plats. One was irrigated by the owner in the usual manner and with the usual amount of water. To one of the other plats more water was applied than the quantity used by the farmer, and to the other plat less water. The results on different tracts differed widely, but in general established the character of irrigation practice employed by the irrigators. Tracts of alfalfa, barley and oats were selected.

The maximum capacity of the ditches and the area irrigated therefrom, considered in connection with the head used in irrigation of individual tracts under the respective ditches, show conclusively that rotation is practiced.

This report, together with the maps showing the irrigated land in each 40-acre tract, ownership plats and a summary of all ditch measurements, was submitted to the superintendent having the adjudication in charge and was considered by him with the claims and evidence submitted by the water-right claimants. Under these conditions it will be an easy matter to keep the finding of the board within reasonable bounds, to the end that justice may be done to all claimants.

Thus we see that engineering data are taking their place in the judicial consideration and determination of water rights in these proceedings. The presentation of these data does not come within the often questioned and sometimes questionable class of expert testimony. It involves the presentation of facts with legal deductions therefrom rather than the expression of an expert opinion.

The entire investigations, including survey, were made and the report was prepared by C. E. Stricklin, Field Assistant for the State Engineer.

Design and Erection Costs of Steel Knock-Down Dredge

A new design of steel dredge was recently brought out by the American Steel Dredge Co., of Fort Wayne, Ind. It is of the single-line type. The improvements pertain to the so-called structural part of the dredge or the front end, embodying the dipper, dipper handle, boom and circle. Dippers in general use are of the square type, but the one on this dredge is made with an exceptionally wide mouth and narrow back. The shell is formed of one piece of flanged steel riveted to the back casting, with a flanged-steel mouthpiece and lower band (Fig. 4).

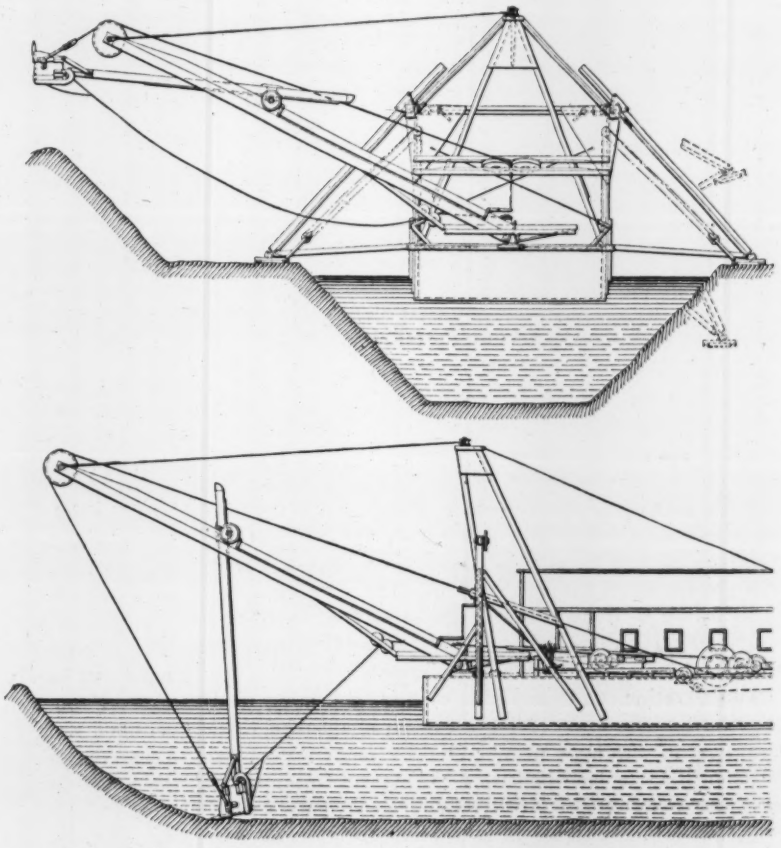

FIG. 1. DESIGN OF LATEST IMPROVED "AMERICAN" STEEL DREDGE

The design of the dipper handle is unique and opens another field for acetylene welding. Dipper handles in common use are of wood or of wood armored with steel plates on the four sides or are made of steel. In the latter instance they are usually built of I-beams reinforced to form a box section. The construction of the new handle is a hollow-steel box section devoid of rivets. The box is formed by coping the flanges of two channels, so that when the latter are placed together they form a section of the proper width. The flanges are then welded for the entire length on both edges. Two of these box sections are required for each handle. The racks are bolted on in the same manner as on a wooden handle. The dipper-handle foot casting is put in place before the channels are welded, so that when this is done the channels contract, resulting in a tight fit on the casting.

FIG. 2. NEW BOOM AND CIRCLE—NOT RIGIDLY CONNECTED

The boom as formerly used on the "American" dredge was built as an integral part of the circle, being attached by numerous small bolts to the comparatively small boom base and also having a rigid member running from the upper side of the boom at the shipper shaft down through the boom and attached rigidly to the outside of the circle.

Four angle braces were also used to brace the boom and circle. Experience showed that digging and swinging unduly stressed parts of the boom and circle on account of the rigid connection. To obviate this, the new boom and circle are built as separate parts with an exceptionally wide base and large-diameter base casting, with wide bearing surface.

The circle is of solid plate construction, securely riveted to the center casting. The boom and circle are pin-connected, with swinging cables running from the circle to the boom, thus permitting the latter to be set at any angle desired and allowing sufficient play to eliminate excessive stresses in the circle. The design of the all-steel boom was also changed by riveting gusset plates on the side and lower chord of the boom (Fig. 2), which is consequently much stiffer, so that it better withstands the stresses in service operation caused by swinging and stopping suddenly.

The dredge has a sectional hull, built entirely of flat steel sections of convenient sizes for easy handling. A complete hull 80x20 ft. in plan by 6 ft. deep can be loaded on one flat-car. The tabulation that follows gives the cost of transporting and erecting one of the new machines. The figures were furnished the manufacturer by the contractor and are for one of the new dredges, equipped with a 1½-yd. dipper and 50-ft. boom, used on a large drainage district in Arkansas.

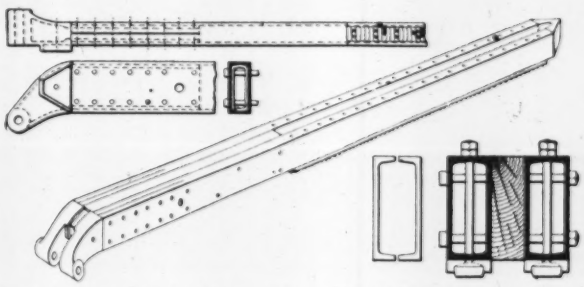

FIG. 3. DIPPER HANDLE FORMED OF TWO RIVETLESS STEEL BOXES

COST OF TRANSPORTING AND ASSEMBLING KNOCK-DOWN DREDGE

Transporting Steel Hull

Hull, weighing 88,000 lb., arrived on job Oct. 22; hauled to bank on Oct. 23 and 24	
60 man-hours @ 20c.	$12.00
110 man-hours @ 17½c.	19.25
20 hours for foreman	8.80
Two days' teaming	19.00
Total	$59.05

Erecting and Launching the Hull

Erection began Oct. 26; completed Nov. 4 (work delayed 1½ days by hull grounding)	
275 man-hours @ 20c.	$55.00
424 man-hours @ 17½c.	74.20
90 man-hours @ 12½c.	11.25
Total	$140.45

Hauling Machinery

Machinery arrived on two cars Oct. 29; hauled to dredge Oct. 30 to Nov. 4	
50 man-hours @ 20c.	$10.00
110 man-hours @ 17c.	18.70
30 hours for foreman	13.20
Total	$41.90

Installing Machinery

Began Nov. 5; completed Nov. 27	
480 man-hours @ 20c.	$96.00
170 man-hours @ 12½c.	21.25
603 man-hours @ 17½c.	105.52
Total	$222.77
Total cost of erecting dredge	$464.17

FIG. 4. DIPPER OF RECENT DESIGN HAVING WIDE MOUTH

Difficult Pump Test Made with Pitot Tube

By C. E. Grunsky*

SYNOPSIS—Difficulties include lack of gaging point outside of discharge pipe, discharge water not under pressure at all points along pipe and air trapped in discharge line. Pitot tube used in spite of high velocity and air in its tubes; velocities measured on two cross-diameters inclined 45° to vertical. Special switching device, reversing manometer connections, used to eliminate error from air accumulation in tubes. Difference in head between pump inlet and discharge measured directly by special manometer rig.

Tests of the centrifugal drainage pumps of the West Sacramento Reclamation District near Sacramento, Cal., under difficult conditions have been successfully carried out. The novelty of some of the features of these tests may be of interest to the profession and has prompted these notes which are presented for the purpose of describing the methods employed and not with any view to discussing the performance of the pump equipment.

The pumping plant consists of two units, each comprising a 48-in. centrifugal pump driven by a two-speed direct-connected electric motor. The suction is double 30-in. at the pumps, fed by a single 48-in. pipe from a sump at the end of the drainage canal. The length of the suction is about 80 ft. and the length of the discharge (riveted steel pipe) 110 ft. On the discharge, just beyond the pump, is a heavy cast-iron flap valve in a suitable enlarged chamber and counterbalanced by outside weights. An air pump is attached for priming the pump and removing accumulated air when necessary.

The two pumps were installed under a guarantee that each would deliver not less than 50,000 gal. of water per min. (111.2 ft. per sec.) under a head of 9 ft., at 194 r.p.m. and that then the average efficiency of both pumps would not be less than 69%. It was also guaranteed that, if operated at 248 r.p.m., each of the pumps would deliver not less than 50,000 gal. per min. under a head of 18 ft. and that then the average efficiency of the two pumps would not be less than 80%. The contract provided that if a test under the two heads showed an average efficiency below 74.5%, there should be a deduction from the contract price, and that in case the guaranteed average efficiency was exceeded, there should be a bonus paid. It was stipulated that the two heads referred to in the guarantee were to be determined from vacuum and pressure-gage readings taken at the inlets and outlets of the pumps, and that the power charged against the pumps was to be the power actually delivered to the pump shafts.

Difficulties of Test

Conditions were favorable in March, 1914, for making the tests. The water at that time was about 8.5 ft. lower in the drainage canals of the district than on the overflowed land outside of the district. The several difficulties of the proposed efficiency test will be briefly explained:

1. The delivery of the pumped water is into the overflow of Yolo basin, a broad expanse of water when the streams are high. There is no opportunity to make a gaging of the discharged water except in the discharge pipes.

2. The drainage canals within the district feed into a main canal leading to the pumping station which, though wide and deep, offered no convenient gaging station close by the pumphouse. A gaging at a remote point would be subject to the objection that the lowering of the water plane during the test might result in appreciable inflow of seepage water the amount of which would be difficult to determine.

3. The pumps discharge over a levee through 48-in. pipes with a summit elevation at the top of the pipe about 6.4 ft. higher than the center of the pumps. At no place on the discharge pipe except where it enters the water of the overflow could it be hoped to find the water at all points in the pipes under pressure.

4. The possibility of using a Pitot tube in the discharge pipes was affected by the common general assumption that this instrument cannot be used except when the water is under pressure. Some difficulty was expected from the high velocity in the pipes, because it would be necessary to traverse the pipe from side to side at one operation, owing to the inaccessibility of the pipe from underneath.

5. Nothing was known of the amount of air likely to be trapped at times at the high points of the discharge pipes.

FIG. 1. PITOT-TUBE RIG, WEST SACRAMENTO PUMP TESTS

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6. The flow of water in the drainage canal at the time of the test was not equal to the capacity of one pump, consequently there was a lowering of the water during the test in the sump from which the water was drawn.

Upon study of the situation it was determined:

1. That the use of a Pitot tube would be feasible even though the velocity was high and there might be some air

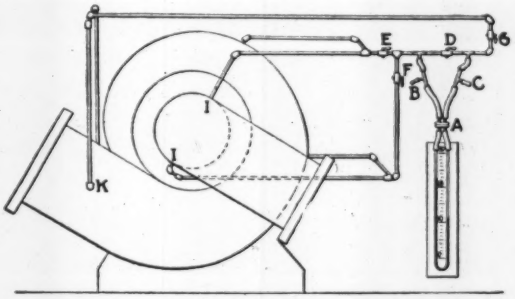


FIG. 2. MERCURY U-TUBE FOR DETERMINING INLET AND DISCHARGE PRESSURE DIFFERENCE

accumulation in its tubes due to lack of pressure in the discharge line.

2. That the water measurement should be made as far from the pumps and as near the level of the discharge water as possible.

3. That the velocities should be measured on two diameters of the discharge pipe normal to each other and inclined at 45° with a vertical plane passing through the center line of the pipe. (A measurement across the pipe on a horizontal traverse seemed to be out of the question because the horizontal position would have made it necessary to gage at a point where the top of the pipe was more than 2 ft. above the surface of the discharge water and this did not seem advisable. Furthermore, velocity determination on a traverse normal to the horizontal from top to bottom of the pipe would have made it necessary to cross with the Pitot tube the zone in which air was most likely to interfere with the observation.)

4. That the errors resulting from accumulation of air in either of the two tubes leading from the Pitot tube to the manometer could be eliminated by alternate use of each tube for determining velocity head and then for suction head.

5. That a special device should be applied to measure directly the difference in head between the inlet and discharge of the centrifugal pumps.

Details of Equipment

Notwithstanding velocities in excess of 10 ft. per sec. the Pitot tube was successfully used. The instrument was of the form with upstream and downstream orifices. The only accident of note was due to the fact that at one insertion the tube turned in its support and the pressure against its flat side bent it somewhat, but without more injury than could be repaired in a few minutes.

A switching device was secured[1] equivalent to a four-way cock with which a quick exchange of connections, as demanded by requirement (4), could be effected. Under the low pressures involved this switching device was found very convenient. It consists of two flat disks, each perforated at two points and provided with nipples for the attachment of rubber hose. The disks were fastened together at the center so as to revolve with faces in contact, so that the holes in one could be successively brought into line with each of the holes in the other. A half-turn and a half-turn back was all that was required to change the manometer connection and to bring it back again to the original position.

During the test at low speed tetrachloride of carbon, with a specific gravity of 1.59 and suitably colored, was used in the U-tube manometer of the Pitot tube. But for the greater pipe velocity, at the high pump speed, it was found that a mercury column permitted sufficiently close readings and was quite satisfactory.

Two things in connection with this test will be of interest to the profession. These are, first, the use of the device to eliminate error due to the possible accumulation of air in the tubes leading from the Pitot tube to the manometer and, second, the direct measurement of the difference in head between pump inlet and pump discharge, making unnecessary the determination of the elevation of the gage in its relation to the pump.

All errors that might arise from the accumulation of air in the connections with the U-tube were eliminated by placing the switching device close to the head of the Pitot instrument. At each turn of the switch a certain amount of water was expelled through the downstream orifice of the Pitot instrument and a like amount entered through the pressure orifice. This amount varied according to the amount of change resulting in the position of the tetrachloride or of the mercury in the U-tube. Under repetition of observations it helped to eliminate error.

The elimination of error due to any trapped air in the tubes connecting the Pitot instrument with the manometer can be shown as follows:

If there was air in the hose leading to the U-tube between the switch and the U-tube and the excess of the air in one leg of the hose amounted to h expressed in water pressure, then the first reading and the second, switched to the other side, would be equivalent to

$$H' = H + h \text{ and } H'' = H - h$$

where H represents the true difference in water pressure, H' the reading with the switch in one position and H''

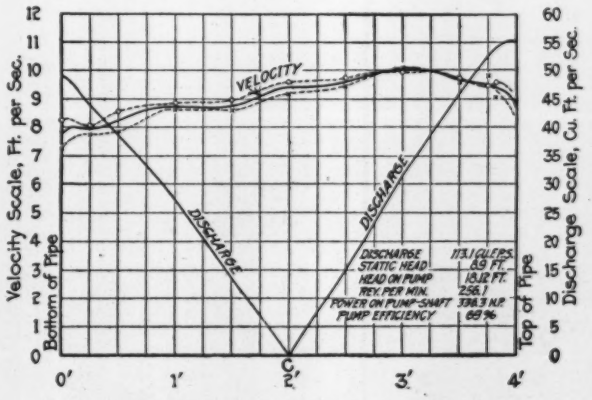


FIG. 3. RESULTS OF SOUTH PUMP TESTS; WEST SACRAMENTO DRAINAGE DISTRICT

the reading with the switch in the other position. From these equations

$$H = \frac{H' + H''}{2}$$

the error h being automatically eliminated.

[1]This was obtained from the A. Lietz Co., of San Francisco, which concern had recently been called upon to construct it for another purpose.

It should be noted that such a switching device makes possible the use of the Pitot tube under vacuum—even in the case of liquids carrying some gas, as in the case of sewage.

Fig. 1 shows the method adopted for handling the Pitot apparatus. It is to be noted that ordinarily a manometer so arranged that a mercury column in a U-tube placed at an inclination with the horizontal of about 1 in 5 will be found more convenient for use than the tetrachloride tube.

The filling of the hose connections between the Pitot instrument and the U-tube required some care. A connection was made with the air pump, and by withdrawing air or water from the highest point of one leg of the connecting hose and then from the other, the tetrachloride column was raised to full height first in one leg of the U-tube and then in the other and this process was repeated until no more air was apparent. When once in working condition no further attention was paid to complete elimination of air, since its presence had no effect on the result of the observations.

The writer could find no precedent for the direct measurement of the difference in head between the inlet and discharge of the centrifugal pump, and he therefore presents the adopted scheme as a novel and successful arrangement which will be found useful under similar conditions.

The inlet pipes of each pump were tapped at *I, I*, Fig. 2, for ¼-in. pipes at the top and bottom on a line normal to the plane of the elbow, and the discharge end of the pump was tapped at both sides at *K*. The pipes or tubes, in part of glass, were connected and brought to the manometer as shown in the sketch.

Use of Test Apparatus

By means of the connections as arranged and cocks placed as shown in Fig. 2, it was possible to note difference in pressure between the discharge and the bottom or the top of the inlets or between the discharge and the combined top and bottom of the inlets. By opening the clamp at *B* (Fig. 2) and the cock *G* and closing the cocks *D, E* and *F*, the apparatus served as a pressure gage on the discharge. By opening the clamp at *C* and the cock *E* or *F* or both *E* and *F* and closing *D* and *G*, the apparatus served as a vacuum gage on the pump inlets. But when used either for measuring the head on the discharge or for vacuum on the suction pipe, the elevation of the scale had to be taken into account.

The use of this apparatus was in every way satisfactory. There was no trouble in setting up a strong flow from the discharge toward the suction by opening the cocks *G, D* and *E* or *F*. Through the glass tubes the flow of water was noticeable, particularly as there was slight air leakage at some of the connections and bubbles of air could be plainly seen as they were carried along by the water.

Between each two observations the cock *D* would be opened for a moment. If any air appeared in the U-tube, as might be the case after opening *C* or *B* for an observation of head on the discharge or of vacuum on the suction, this was easily gotten rid of by manipulating the switch and letting the mercury in the U-tube play up and down a few times.

To take an observation the water was first allowed to flow for a moment through *G, D, E* and *F*, and then *D* was closed. The switch at *A* was turned so as to disconnect the U-tube and bring the mercury to complete rest, and a reading was noted. Thereupon the half-turn of switch *A* was completed, and with a reversed position of the mercury columns a second reading was taken. In order to eliminate all chance of error, 10 double readings were taken to complete a set, and a new set was taken at first every 10 min. but later every 15 or 20 min. during the continuance of a test, the full time of which was determined by the time it took to make the two traverses of each discharge gaging—generally from 1 to 1½ hr.

Some of the results of the test are presented in Table 1—for those who desire to follow the test and not for the interest in the pumps.

TABLE 1. RESULTS OF TEST; WEST SACRAMENTO DRAINAGE PUMPS

	North Pump		South Pump	
	Low Speed	High Speed	Low Speed	High Speed
Water elevation in suction sump, ft.	8.50	7.46	8.51	7.70
Water elevation at discharge, ft.	16.50	16.45	16.50	16.50
Static head, ft.	8.00	8.99	7.99	8.80
Loss of head in suction pipe, ft.	3.02	6.14	2.27	3.90
Loss of head in discharge pipe, ft.	2.34	4.30	2.92	5.42
Head on pump, ft.	13.36	19.43	13.18	18.12
Revolutions per minute	200.3	255.3	200.1	256.1
Hydr. grade at inlet, ft.	5.48	1.32	6.24	3.80
Hydr. grade at outlet, ft.	18.84	20.75	19.42	21.92
Water pumped, cu.ft. per sec.	78.0	110.1	74.7	113.1
Water pumped, gal. per min.	34,900	49,400	33,500	50,800
Horsepower of water passing through pump	118.1	242.4	111.5	232.2
Electric power input, hp.	185.9	368.9	188.3	365.9
Power on pump shaft, hp.	167.1	339.0	169.3	336.3
Efficiency of pump, per cent.*	70.7	71.6	65.8	69.0

*It is to be noted that neither at high speed nor at low speed could conditions be obtained in exact conformity with those intended under the contract and that therefore these efficiencies are not comparable with the guarantee without suitable modification.

In Fig. 3 are shown the two velocity curves (for the separate traverses) and the discharge curves, obtained at the high speed for the south pump. The discharge as shown by this diagram is the area between the base line representing the diameter of the discharge pipe and the two parts of discharge curve which rise from the middle of this diameter and terminate at vertical lines representing the top and bottom of the pipe. The points on the discharge curve were obtained by multiplying average velocity in feet per second at any selected point, as indicated by the two curves, with the half-circumference in feet of a circle having a radius equal to the distance of that point from the center of the pipe. In the original diagrams each square inch of surface represented 5 cu.ft. per sec.

The close agreement of the velocities on the two traverses is to be noted. This agreement was somewhat better in the selected example than in the case of the other three gagings—but all were quite satisfactory. In Table 2 a sample of the readings, in inches of mercury, taken on the pressure manometer to determine head on the pump is presented.

TABLE 2. MANOMETER READINGS. PART OF LOW-SPEED TEST; NORTH PUMP, WEST SACRAMENTO RECLAMATION DISTRICT

	First Position		Second Position			First Position		Second Position	
Time	Discharge, In.	Suction, In.	Discharge, In.	Suction, In.	Time	Discharge, In.	Suction, In.	Discharge, In.	Suction, In.
10.00	6.02	19.05	6.15	18.93	10.20	6.00	19.07	6.06	19.06
	6.10	19.00	6.15	18.95		6.07	19.03	6.10	19.00
	6.12	19.02	6.13	18.93		6.20	18.90	6.01	19.09
	6.20	18.90	6.06	19.04		6.00	19.10	6.10	19.00
	6.10	19.00	6.10	19.00		5.90	19.20	6.13	18.97
Average	....	.....	6.11	18.98	Average	....	.....	6.06	19.04
Diff.	....	.....	....	12.87	Diff.	....	.....	....	12.98
10.10	6.11	18.97	6.12	18.98	10.30	6.20	18.91	6.00	19.02
	6.23	18.85	6.08	19.01		6.18	18.92	6.05	19.04
	6.22	18.88	6.09	19.01		6.20	18.90	5.98	19.12
	6.13	18.97	6.14	18.94		6.10	19.00	6.02	19.02
	6.20	18.90	6.28	18.82		6.03	19.03	6.11	18.98
Average	....	.....	6.16	18.93	Average	....	.....	6.08	18.99
Diff.	....	.....	....	12.77	Diff.	....	.....	....	12.91

Note: Multiply by 1.049 to convert inches of mercury to feet of water.

There were observations taken, with the apparatus as described, to determine separately the vacuum at the inlet of the pump and the pressure in the discharge. These observations checked the result of the direct measurement of total head on the pump and afforded the means for determining the loss of head in the suction and in the discharge pipes, as noted in Table 1. Observations were also taken to determine whether there was any difference in the vacuum indicated by the connection at the bottom of the inlet elbow from that indicated by a connection at the top, but none was apparent.

The samples of the readings as noted in Table 2 show that there was but slight fluctuation in the head on the pump during the taking of each set of readings.

Load Test of Concrete Floor Cracked by Settlement

By J. H. Byrd*

The concrete beam-and-slab floor of a recently built paint and oil warehouse cracked soon after construction, across the line of the beams near the contraflexure point of one bay, over the whole width of the building. The crack was probably caused by settlement of one end of the building, due to yielding foundations. The safety of the structure being questioned, a load test was made. The surprising result was that the floor carried a very heavy test load—500 lb. per sq.ft.—and thus demonstrated that it was safe.

The building is shown in plan and part sections in the accompanying sketch. All supports for the contents, partitions and other dead-loads were in place. The building was practically completed when the cracks were noticed.

The building has only one floor and roof, and on this account a cheap type of foundation was adopted. The footings were placed directly on wet gumbo soil, probably about 10 ft. thick above sand, with a unit pressure of 1,500 lb. per sq.ft. They were balanced for dead-load, but this apparently did not prevent the uneven settlement. In filling the ground around the building, sand was pumped from the river; and as the water drained off to the lower levels, the footing pits provided fine sump basins.

As shown by cracks in the loading dock at one end of the building, the ends of the building evidently settled. In spite of this a construction joint across the center of a panel near midlength of the building showed no crack. A crack appeared, however, in the second panel from one end, at the contraflexure point of the joist, as indicated in the plan. The settlement of the building is not apparent in levels taken from a benchmark or relative to the rest of the building. On the other hand, as the building was started in the winter months the cracks were evidently not caused by contraction of the concrete, but must have been caused by settlement. The crack continues all the way across the building through the wall beams and penetrates the slab sufficiently so that water can drip through. It is perpendicular to the floor and at places opens up to $\frac{1}{16}$ in.

It was at first thought necessary to build a brick or concrete wall under the broken joists to make the floor safe. However, it was decided to make a load test to gain information on the safety of the building.

An area 20x13 ft. was loaded with wet sand 5 ft. high, making 500 lb. per sq.ft., a total load of 130,000 lb. The maximum deflection at midspan was $^{3}/_{64}$ in.; at the crack, $\frac{3}{32}$ in. Most of the deflection occurred under the first 100 lb. The load was left on overnight, about 16 hr., and no additional deflection was noticed. After the load was removed, the crack was slightly closed. Permanent deflection was not apparent. The surface of the floor was perfectly smooth at the crack.

Thin grout will be allowed to seep through the crack; and, as the floor was designed for 250 lb. per sq.ft. and carried 500 lb., it will be considered safe for the purposes intended.

The writer's idea was that arch action (the joist being cambered ½ in.) would produce sufficient binding action at the broken section to take care of vertical shear. The success of the test seems to indicate that this action took place. Any deflection sufficient to overcome the arch action would have opened the joint and probably caused failure, there being no tension steel at the point of the crack.

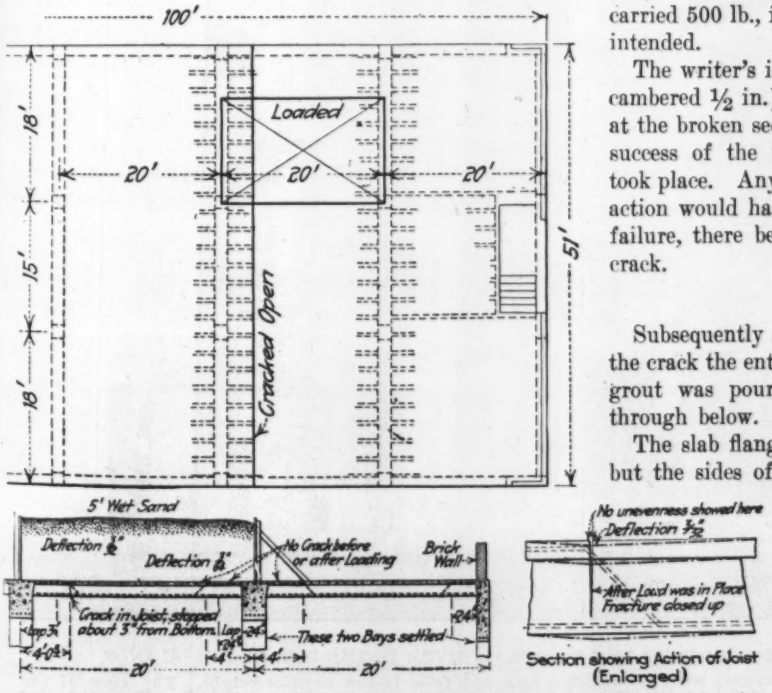
Repair of the Crack

Subsequently a V-shaped slot 2 in. wide was cut along the crack the entire width of the floor. Very thin cement grout was poured into this slot. The water dripped through below.

The slab flange of the joists appears to be filled solid, but the sides of the joists show the same fracture, and the crack here can evidently be filled only by forcing in grout under air pressure. This will not be attempted.

The floor has now received nearly its full live-load, consisting of machinery, steel tanks, oil, varnish, etc. No further evidence of trouble has appeared.

*Structural Engineer, 602 Finance Building, Kansas City, Mo.



PLAN AND SECTION OF FLOOR TESTED AFTER CRACKING

Aërial Tramway as Substitute for a Bridge

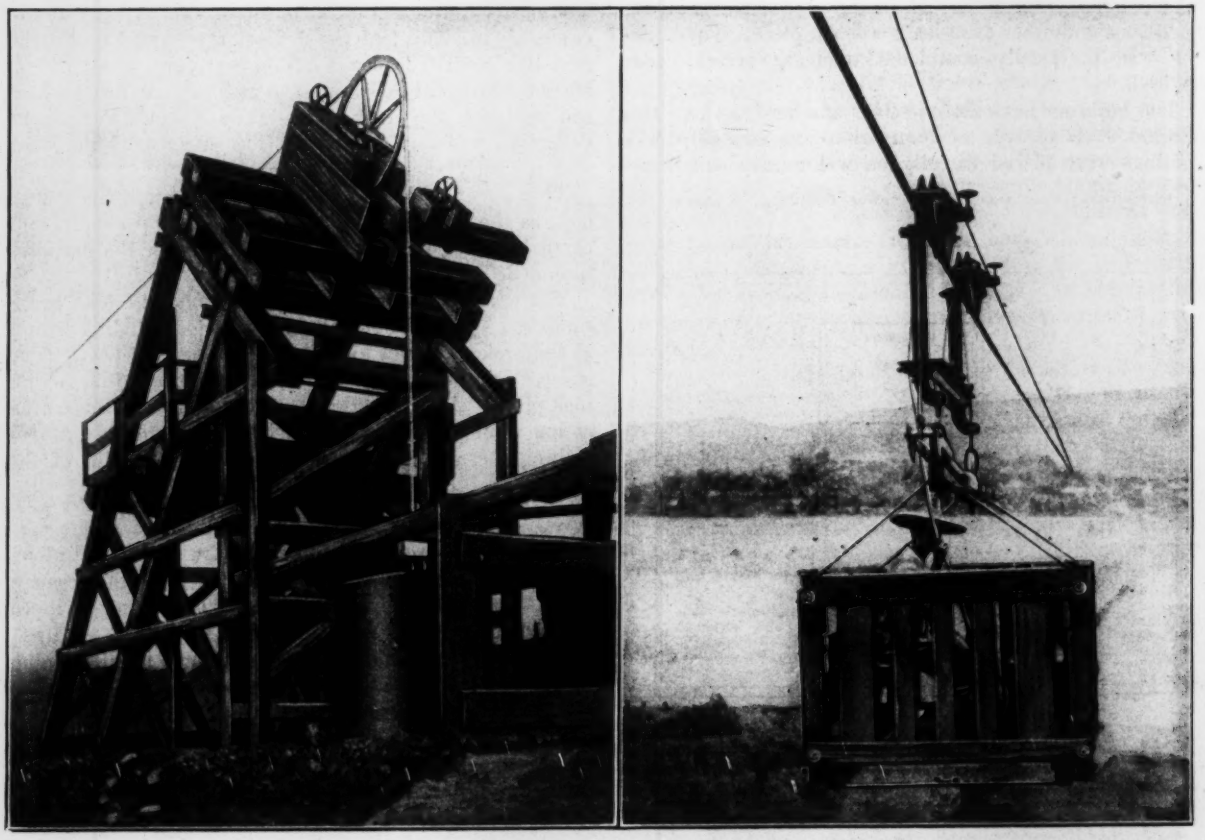
SYNOPSIS—A two-span cable tramway carries passengers across a river at times of flood. The method of erecting the 1,840-ft. cable is described.

An aërial tramway taking the place of a highway bridge is the feature of the crossing of the Naguilan River by the Bauang-Baguio road, in the Philippine Islands (La Union Province). The river is about ⅓ mi. wide between banks, has a flood rise of 25 ft. above low water, and the crossing may be unsafe for boats or rafts for several days. A steel bridge has been designed; but as conditions do not warrant its construction at this time, some means had to be devised for maintaining communication during high water. The tramway was built for this purpose. For ordinary service there is a timber trestle.

The tramway has two spans of 857 and 906 ft., the cables being supported by three timber towers—two on shore and one on a concrete pier that eventually will form one of the bridge piers. The towers are of ipil (a native hardwood) and Oregon pine, and the posts of the shore towers rest on concrete footings. At the towers the cables are carried at an elevation of about 55.76 ft. above low water. For the track cable this allows a dead-load sag of 7½ ft., a live-load sag of 14½ ft., a clearance of about 18 in. from flood level to the car and 7¼ ft. from the bottom of the car to the cable trolley. Stairs lead from the ground to the landing platform at the car level. A telephone line is carried across the towers.

The track cable is a 1¼-in. plow-steel cable (with six 19-wire strands), purchased from stock in Manila. The ultimate strength is 68 tons, and (with a factor of safety of 4) a working load of 17 tons was allowed. At the west end the cable is secured to an anchorage. Through the cable socket pass two 1½-in. eye-bolts 15 ft. long, whose ends engage a 3¼-in. pin in the head of a 1x4-in. eye-bar 26 ft. long. The lower end of the bar has a similar pin 2 ft. long, engaging a grillage of steel bars in a concrete anchor block 6x4¼x7½ ft. This block weighs about 9 tons, and the space between it and the face of the excavation was filled with concrete to insure stability.

At the east end the cable is not anchored, but passes over a grooved pulley on the tower and is attached to a cylindrical concrete counterweight 6 ft. 2 in. in diameter and 8 ft. 2 in. high. This is shown in one of the



AËRIAL TRAMWAY FOR PASSENGERS; CROSSING THE NAGUILAN RIVER IN THE PHILIPPINE ISLANDS

The view at the left shows the east tower, with track cable attached to a 17-ton counterweight. The view at the right shows the car and carrier. The road and bridge (for use at low water) are shown beyond the car. The conductor is holding the safety cord for releasing the haulage rope in case of overwinding

accompanying views. The counterweight weighs about 17 tons, but an annular recess in the top provides for an additional loading of about a ton of sand and gravel to compensate for stretching of the cable. Threaded rods anchored in the concrete form the attachment of the cable socket. This block was built in place and in elevated position (with its top just below the top of the tower), the form being supported on timber blocking. The cable sockets are semisteel castings 5¾x12 in. and 10 in. long. In the center is a hole tapering from 3½ to 1¼ in.; this receives the cable end, the wires being spread and bent back and the space filled with zinc. At each side is a hole for the anchor rod, these holes tapering from $2\frac{1}{16}$ in. to $1\frac{9}{16}$ in.

The car is an open timber box 5 ft. by 4 ft. 8 in., 3½ ft. deep, weighing about 400 lb. It is suspended from a carrier attached by hangers to a pair of two-wheel trolleys riding on the cable, as shown. The weight of car, carrier and trolleys is about 1,150 lb., while six passengers and a conductor bring the total live-load to 2,200 lb. At the landings the car is hooked to the tower posts to hold it steady. The conductor holds a safety cord for instantly releasing the car from the hauling cable in case of overwinding. Large animals are carried in a canvas hanger, the car body being then detached from the suspenders.

The ⅜-in. haulage cable passes around a horizontal 11-ft. driving sheave built on the ground behind the east tower and supported on a framing of timber beams. The wheel is built of three layers of Oregon pine plank, 3x12-in. for the top and bottom layers and 2x12-in. for the middle layer. The edges of the 3x12-in. planks are beveled to form a groove for the cable.

The under side of the wheel has runners that ride on hardwood (molave) rollers 5 in. long, tapering from 5 to 5½ in. in diameter. It has a pivot of ipil wood, 12 in. in diameter with a 9x9-in. bottom plate that rests on a hemispherical bearing plate bolted upon a concrete base 39x32 in. The upper bearing of the pivot is braced against the tower. Wedges allow for taking up shrinkage.

Guide pulleys lead the haulage cable to the driving sheave, around which it makes 1½ turns. This sheave is operated by two carabaos—or water buffaloes—hitched to a pair of timbers projecting on opposite sides. The stress on the haulage cable with loaded car (seven persons) is about 1,020 lb.

Preparing and Erecting the Cable

The 1¼-in. track cable (supplied in three coils) was stretched out along the road on the west side of the river, all twists and turns being taken out and each of the two splices made 50 ft. long. The required length between sockets, 1,838 ft. 5 in., was measured carefully with a 20-m. tape and checked twice. To this length was added—at each end—10 in. for the socket and 7 in. for bending back the wires into the socket. The total distance—1,840 ft. 4 in.—was marked by fine wires wound firmly around the cable, and the strands were then cut one by one. The cable was afterward hauled across the river, passing through the central tower.

After the sockets had been applied, the socket on the east end was fastened to the rods in the top of the counterweight, which was elevated on blocking, as already mentioned. Then the cable was pulled up to rest on the saddles of the west and central towers and the sheave of the east tower, the saddles and sheaves being well lubricated with axle grease. The west end was about 33 ft. from the anchorage attachment, the eye-bolts of which were held in position by a timber support, or horse.

A timber deadman 12x12 in., 15 ft. long, was placed vertically (set 10 ft. in the ground) behind the anchorage. Around this was placed a 4-ft. loop of three turns of 1¼-in. wire cable, and to this the hook of a double 24-in. diamond sheave was secured. On the main cable, beginning about 20 ft. from the socket, was lashed a 15-ft. loop of two lines of 3-in. hemp rope, the strands of which were unlaid for about 4 ft. and wrapped around the cable. The hook of a second 24-in. block was secured to this loop.

A 300-ft. length of ¾-in. steel cable was run through the two sheaves, one end being clamped at the block on the deadman and the other end being free for attachment to the axle of a 40-hp. 2½-ton motor truck, loaded with a ton of freight. Between the towers and the center pier the cable lay on the ground for about 66% of the distance. Men were sent up the center and west towers to keep the under side of the cable well lubricated with axle grease.

The motor truck then moved off; and when the cable swung free (almost simultaneously in the two spans), nearly the maximum power was needed to keep the truck moving. When the socket was within a short distance from the anchor rods, the pull of the cable was greater than the tractive effort and the truck stalled. By putting chains on the rear wheels, piling the freight directly over them and then working the engine with full admission of gasoline a little further advance was made, bit by bit.

Finally by applying full power and clamping the brakes to hold the slight advantage gained the socket was swung into such position that the eye-bolts (pivoted to the head of the anchor bar) could be passed through it, with just enough length projecting to hold the nuts. The washers and nuts were applied and turned with long-handled wrenches. As the nuts took up the thread, the truck was able to move ahead a little, thus relieving the strain on the nuts, the operations being repeated until the socket had been forced to the determined position on the bolt. The hauling line was then slacked gradually, until the anchorage took the full strain.

The next stage of operations was at the counterweight end of the cable (east end). The counterweight had been built in an elevated position, on blocking. By jacking slightly with four 60-ton hydraulic jacks the top 12-in. course of blocking was released and replaced with three 4-in. pieces, the counterweight being then jacked and lowered in 4-in. stages. This was repeated until it had been lowered about 6½ ft.

Then the car was loaded to 3,000 lb. with boulders and run out to the middle of the east span. As this did not suffice to raise the counterweight, the load was gradually increased to 7,000 lb., when the counterweight lifted ½ in. The jacks and blocking were at once removed, and the load on the car was reduced.

The total cost of this aërial tramway, including the towers and concrete pier, was $8,142. The foregoing information has been compiled from a paper in the "Bulletin" of the Bureau of Public Works (Philippine Islands), by Frank T. James, of Manila, who acted as supervising engineer.

Prorating Paving Cost Among Property Owners

By H. M. Talbott*

In 1915 the City of Owensboro, Ky., let by contract 6,124 lin.ft. of bitulithic pavement. Of this, 5,187 ft. was resurfacing on the existing concrete foundation, formerly surfaced with sheet asphalt; 270 ft. on new concrete foundation; and 667 ft. on macadam foundation, after the latter had been scarified and properly rolled.

Payment for the work was met by the abutting property owners, and the contractors were to collect the assessments according to the estimates furnished by the city engineer. This plan of payment involved 169 separate parties to the contract instead of the usual two. It is readily seen that complication could easily arise unless a systematic method of distributing quantities and figuring estimates was employed.

Measuring the Work for Assessment

Measurement was started at one end of the work, considered as Sta. 0 plus 00; and each property line was located by pluses, the property owner's front being found by subtracting the station number at each side of his property. In this way the measurement was made as a whole and the error in measurement reduced to a minimum.

The City R.R. ran over the streets where resurfacing was done, at some points single track and at others double. The street width varied in different blocks. A city ordinance required that the pavement be charged to the property owners at so much per running foot; but as the square yards per running foot varied, the estimate was figured on a square-yard basis. When the total cost to the property owner was determined, it was divided by the front feet of property, giving the cost per lineal foot.

In most Southern towns (especially the older ones) property lines do not agree with the lines shown by the deeds. In some instances there has been deeded as much as 10 ft. exceeding the block measurement. At other times there is a surplus not owned by anyone, according to the deeds; but, needless to say, the space is occupied. The measurements were made of the space actually occupied or claimed by the property owner and charged to him whether or not the distance shown agreed with his deed. Where the deed distance was more than the lineal feet as shown by the estimate, the property owner of course did not demur; but in some cases, where he was charged with more lineal feet than was shown by his deed, objections were raised. Cases of this kind were soon adjusted when he was told that he occupied more ground than he paid for and that the city would pay the assessment on the surplus, provided it could get a deed to the ground in excess of the deed distance.

In some places property lines could not be determined, as, for instance, where there was a stairway between two buildings. When this occurred, measurements were taken to what, in the judgment of the field man, was the property line; and estimates were issued on that basis. If there was an error, the property owner charged in excess was quick to have the error adjusted.

Since so many conflicting explanations were made to the field men about the location of the property line, it was thought best to get as nearly as possible the right line and let the owners adjust it between themselves. Where the property line was moved, as agreed upon by the owners, the plus was changed to conform to it; and automatically the frontage of the property on both sides or on one side was changed. The city paid for all street intersections (Fig. 2), and the City R.R. paved with concrete for 3½ ft. on each side of center line of track.

In tabulating the estimates six sheets were used similar to Table 1; one sheet, Table 2; one sheet, Table 3; and two sheets, Table 4.

Resurfacing on Existing Concrete Foundation

In resurfacing on the existing concrete foundation (Fig. 1) there were four items to be considered—top surface, binder, concrete and removing old asphalt.

The square yards fronting the property was found by the usual method of multiplying the front feet by the

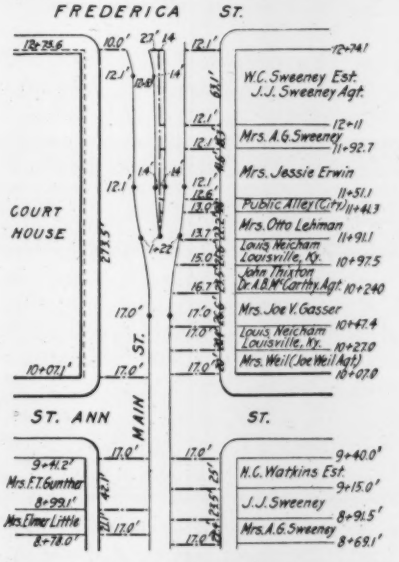


FIG. 1. SHOWING HOW ABUTTING PROPERTY OWNERS WERE ASSESSED ON MAIN ST.

width of improvement and dividing by 9. Where the area was irregular, caused by the existence of turnouts in the City R.R. tracks, the usual method of triangles and trapezoids was followed, as shown by the sketch of the street on the right of Fig. 1.

The binder was brought to a uniform grade and the old concrete foundation was irregular. For these reasons the binder was not of uniform thickness. Hence it was paid for by the ton instead of by the square yard. In some cases no binder was used while in others four or five tons was laid. The manner of distributing the binder cost was as follows: The total number of tons of binder was determined by actual weight as it left the mixing plant and amounted to 858.04 tons. This was divided by the total square yards of improvement, and the decimal 0.0445 ton was applied to each square yard.

There were several places where the old foundation needed patching. The actual amount of concrete used was determined in cubic yards and the cost was distributed by the same method as that of the binder. The decimal 0.00157 cubic yard was found and applied to each square yard of improvement.

The square yards of old asphalt removed was the same as the square yards of top surface placed.

*City Engineer, Owensboro, Ky.

TABLE 1. DATA ON BITULITHIC PAVEMENT ON MAIN ST., OWENSBORO, KY., FOR ASSESSMENT OF ABUTTING PROPERTY OWNERS

Property Owners	Lot Front, Lin.Ft.	Sq.Yd. Irregular Account, Double Track, Fig. 1	Total Sq.Yd. per Lot	Top Surface Price per Sq.Yd.	Top Surface Cost per Lot	Binder Weight in Tons, Binder per Sq.Yd.	Binder Weight in Tons per Lot	Binder Price per Ton	Binder Cost per Lot	Concrete Cu.Yd. Concrete per Sq. Yd. of Improvement	Concrete Cost per Lot	Concrete Price per Cu.Yd.	Concrete Cost per Lot	Removing Old Asphalt Price per Sq.Yd.	Removing Old Asphalt Cost per Lot	Total Cost	Cost per Lin.Ft.
W. C. Sweeney Est. (J. J. Sweeney, Agt.)	63.1	94.65	94.65	$1.45	$137.24	0.0445	4.21	$2.50	$10.53	0.00157	$0.15	$6.00	$0.90	$0.015	$1.42	$150.09	$2.38—
Mrs. A. G. Sweeney	18.3	27.45	27.45	1.45	39.80	0.0445	1.22	2.50	3.05	0.00157	.05	6.00	.30	.015	.41	43.56	2.38+
Mrs. Jessie Erwin	4.16	62.40	62.40	1.45	90.48	0.0445	2.78	2.50	6.95	0.00157	.10	6.00	.60	.015	.94	98.97	2.38—
Public Alley (City)	9.8	14.75	14.75	1.45	21.39	0.0445	.66	2.50	1.65	0.00157	.02	6.00	.12	.015	.22	23.38	2.38+
Mrs. Otto Lehman	22.2	33.57	33.57	1.45	48.68	0.0445	1.49	2.50	3.73	0.00157	.05	6.00	.30	.015	.50	53.21	2.39+
Louis Neicham (Louisville, Ky., 2304 West Hill St.)	21.6	34.44	34.44	1.45	49.94	0.0445	1.53	2.50	3.83	0.00157	.06	6.00	.36	.015	.52	54.65	2.53+
John Thixton (Dr. A. B. McCarthy, Agt.)	23.5	41.39	41.39	1.45	60.01	0.0445	1.84	2.50	4.60	0.00157	.06	6.00	.36	.015	.62	65.56	2.79—

TABLE 2. DATA ON BITULITHIC PAVEMENT FOR ASSESSMENT AT INTERSECTIONS; WITH TYPICAL INTERSECTIONS

Street Intersection	Sq.Yd. per Intersection	Top Surface Price per Sq.Yd.	Top Surface Cost per Intersection	Binder Weight in Tons of Binder Sq.Yd.	Binder Weight in Tons per Intersection	Binder Price per Ton	Binder Cost per Intersection	Concrete Cu.Yd. Concrete Improvement	Concrete Cu.Yd. per Intersection	Concrete Price per Cu.Yd.	Concrete Cost per Intersection	Removing Old Asphalt Price per Sq.Yd.	Removing Old Asphalt Cost per Intersection	Cost of Intersection
Lewis and Main St.	141.80	$1.45	$205.01	0.0445	6.31	$2.50	$15.78	0.00157	0.22	$6.00	$1.32	$0.015	$2.13	$224.81
Daviess and Main St.	363.89	1.45	527.64	0.0445	16.19	2.50	40.48	0.00157	0.57	6.00	3.42	.015	5.46	577.00
Allen and Main St.	354.11	1.45	513.46	0.0445	15.76	2.50	39.40	0.00157	0.56	6.00	3.36	.015	5.31	561.53
St. Ann and Main St.	401.04	1.45	581.51	0.0445	17.84	2.50	44.60	0.00157	0.63	6.00	3.78	.015	6.02	635.91
Frederica and Main St.	343.63	1.45	498.26	0.0445	15.29	2.50	38.22	0.00157	0.54	6.00	3.24	.015	5.15	544.78
Third and Frederica St.	443.55	1.45	643.15	0.0445	19.74	2.50	49.35	0.00157	0.69	6.00	4.14	.015	6.65	703.29
Fourth and Frederica St.	338.56	1.45	490.91	0.0445	15.07	2.50	37.68	0.00157	0.53	6.00	3.18	.015	5.08	536.85

TABLE 3. TYPICAL ASSESSMENT SHEET FOR PAVEMENT LAID ON NEW CONCRETE FOUNDATION

	Lot Front Lin. Ft.	Width of Improvement	Sq.Yd. Fronting Property	(Bitulithic) Top Surface Price per Sq.Yd.	(Bitulithic) Top Surface Cost per Lot	Concrete Price per Sq.Yd.	Concrete Cost per Lot	Excavation Cu.Yd. Excavation per Sq.Yd. Improvement	Excavation Cu.Yd. Excavation per Lot	Excavation Price per Cu.Yd.	Excavation Cost per Lot	Total Cost per Lot	Cost per Lin.Ft.
S. W. Anderson	56.9	18.5	116.96	$1.45	$169.59	$0.55	$64.33	0.272	31.81	$0.50	$15.91	$249.83	$4.39+
Lee Hart	86.8	18.5	178.42	1.45	258.71	.55	98.13	0.272	48.53	.....	24.27	381.11	4.39+
W. A. Clark	35.7	18.5	73.38	1.45	106.40	.55	40.36	0.272	19.96	.....	9.98	156.74	4.39+

TABLE 4. TYPICAL ASSESSMENT SHEET FOR PAVEMENT LAID ON EXISTING MACADAM FOUNDATION

Property Owner	Front Lin.Ft. Lot	Width of Improvement	Sq.Yd. Fronting Property	Sq.Yd. in Intersection	Top Surface Price per Sq.Yd.	Top Surface Cost per Lot or Intersection	Scarifying Price per Sq.Yd.	Scarifying Cost per Lot or Intersection	Foundation Stone Cu.Yd. Stone per Sq.Yd. Improvement	Foundation Stone Cu.Yd. Stone per Lot or Intersection	Foundation Stone Price per Cu.Yd.	Foundation Stone Cost per Lot or Intersection	Total Cost for Lots	Cost per Lin.Ft.
Loven Whitley	132.1	18.5	275.21	.....	$1.45	$399.05	$0.10	$27.52	0.1	27.52	$1.50	$41.28	$467.85	$3.54+

Under the head of "Laying Bitulithic on a New Concrete Foundation" the items "Top Surface (Bitulithic) in Square Yards," "Concrete in Cubic Yards," and "Excavation in Cubic Yards" were considered, as shown by Table 3. No binder was used, the top surface being laid directly on the concrete, which had been roughened to receive it.

Where pavement was laid on macadam foundation (Table 4), the items "Top Surface in Square Yards," "Scarifying in Square Yards," and "Foundation Stone in Cubic Yards" were considered. Streets where this work was done were of macadam. In surfacing them with bitulithic the old surface was scarified and brought to a uniform grade 4 in. below subgrade. Enough clean stone was placed so that when rolled the subgrade was uniform and 2 in. below the finished grade. The 2-in. top of bitulithic was then laid, no binder being used.

In the two classes of pavement just considered the method of uniform distribution of costs and quantities which was followed was similar to that on the work where bitulithic was laid on the existing concrete foundation.

This method of preparing estimates may not be new; but perhaps this description of it will offer a suggestion that may be of use to city engineers who have estimates of this kind to prepare. There is a rapid growth of city paving invading towns no larger than Owensboro (16,000) and in many cases the city engineer has not been called upon to do this kind of work before.

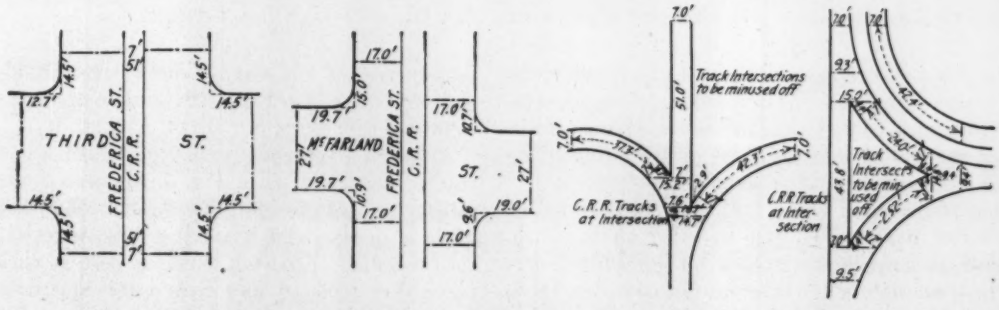


FIG. 2. TYPICAL STREET INTERSECTIONS

Miscellaneous Street Signs

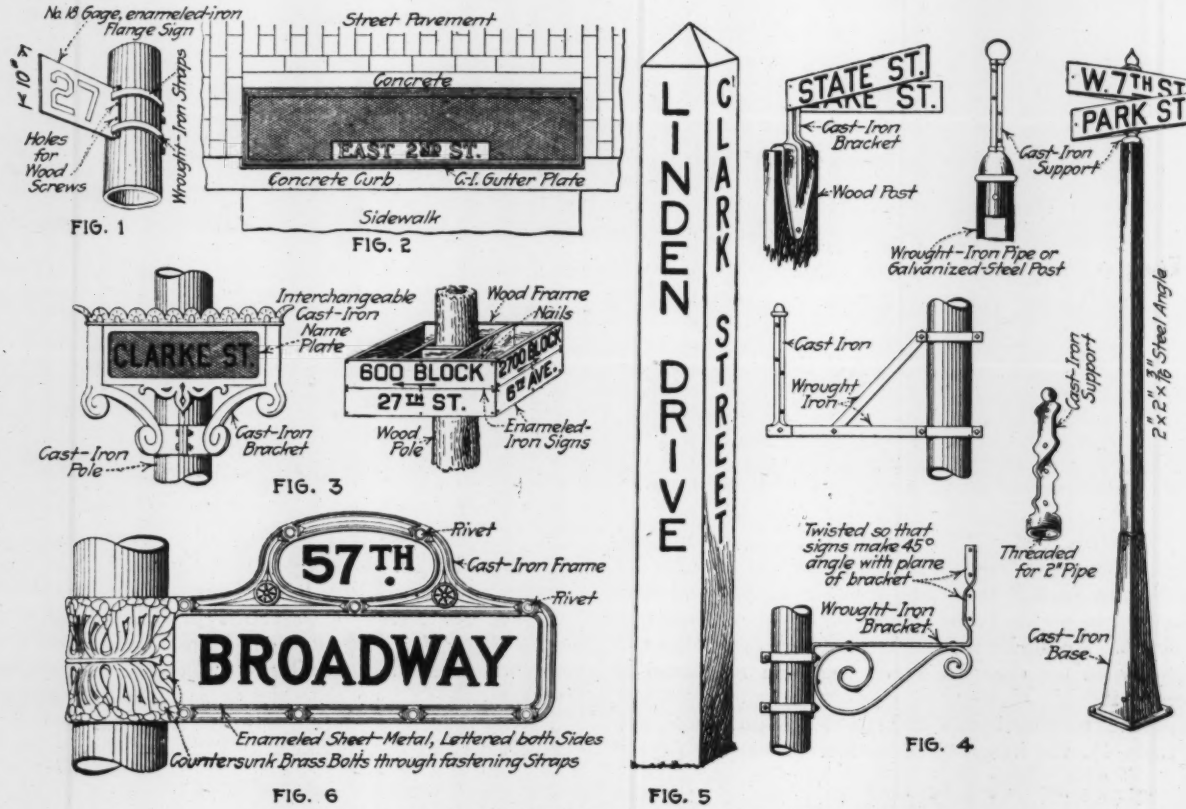
Street signs are of many designs and are placed in all sorts of positions at the street corners. Rolland S. Wallis has treated this subject quite fully in a recent publication[1] of the Iowa State College. The sketches and views herewith show some of the less common methods of designating street intersections.

Fig. 1 is known as the flange sign and has been used with satisfactory results in Cleveland. It is fastened to wooden poles with screws or clamped to metal poles with thin metal straps, as illustrated, and is used to supplement the ordinary street signs placed at the intersections. In Fremont, Neb., the street names are carried on cast-iron gutter covers, as shown in Fig. 2. This plan while fairly

The box type of sign is shown in Fig. 3. The box at the right is of wood and is the type used in Syracuse, N. Y. It is nailed or bolted to wooden or metal posts.

Enameled-Iron Signs Used Extensively

Of the cities from which data were obtained by Mr. Wallis, more than one-half use enameled-iron signs to a greater or lesser extent. The cheapest signs of this construction are prone to develop such faults as fading, tarnishing, chipping, or peeling of the enamel, followed by rusting of the exposed metal. Good vitreous enamels carefully applied, each coat being fused or baked on at high temperature, are essential to permanence. One of this character should remain legible for from five to ten years and reliable manufacturers usually guarantee their signs



FIGS. 1 TO 6. STREET-NAME SIGNS OF VARIOUS PRACTICAL DESIGNS

convenient for pedestrians is of practically no value to vehicular traffic. Furthermore, in Northern cities accumulations of snow and ice will cover the names during certain portions of the winter season. Toronto discontinued the practice of sidewalk signs after some years' trial.

Now that street curbs are so frequently constructed of concrete, street names are often stenciled on the curb. This method, also, has limitations, as can be readily understood. The illumination of curb signs is a new idea. Several of Fig. 7 have been installed experimentally in San Francisco and Los Angeles. It consists of a waterproof cast-iron box 40 in. long by 8 in. high, with the front face perforated. Illumination is furnished by three tubular electric lamps connected to the city lighting system. The box is provided with a removable top plate.

[1]Bulletin 20, "Street-Name Signs," Iowa State College, Ames, Iowa.

for a period of ten years. These signs should be backed with wood to stiffen them. Several devices for supporting enameled-iron signs are shown in Fig. 4.

A square wooden post carrying the names of the streets, painted vertically, as in Fig. 5, has been found the most satisfactory sign for outlying districts of Spokane, Wash., while a similar sign is used in Los Angeles, Calif., for corresponding districts. Such a post is cheap, readily renewed or replaced, and gives a neat appearance.

The standard sign of New York City is shown in Fig. 6. It consists of a two-piece cast-iron frame, the two pieces riveted together with a double-face enameled-iron sign placed between. The two wings of the sign, only one of which is illustrated, are set at angles slightly exceeding 93° for right-angle streets. The cost of the malleable-iron frames is $5 per set, while the cost of the sign is 77c. The cast-iron signs have cost $5.75 to $6.91 in place.

The standard sign used in San Francisco costs the city only $1.75 erected. The sign is of enameled iron with white letters on a brown field held in a frame of bronze.

Fig. 8 shows the bronze name-plate used in the downtown district of Denver, Colo. It is cast in one piece, has polished letters and a dark background and carries two street names. It is fastened to the combination light and trolley poles at each street intersection, being placed so that it can be read from the sidewalk side. This sign costs $3.50 set in place.

Concrete Street Signs

The use of concrete as material for constructing street-name signs is novel at the present time, but it has proved practicable. Two such signs are shown in Fig. 9. These were designed and installed recently by the Department of Public Works of Pittsburgh. Both post and signboard are of granite-finished concrete. The design shown at the left is modified as a Lincoln Highway marker. The sign-plates are separate from the post, being so constructed that they swing about a vertical axis and may be clamped at any desired angle. The letters, of a black cement composition of permanent color, are about ⅜ in. thick and dovetailed securely into the concrete of the background.

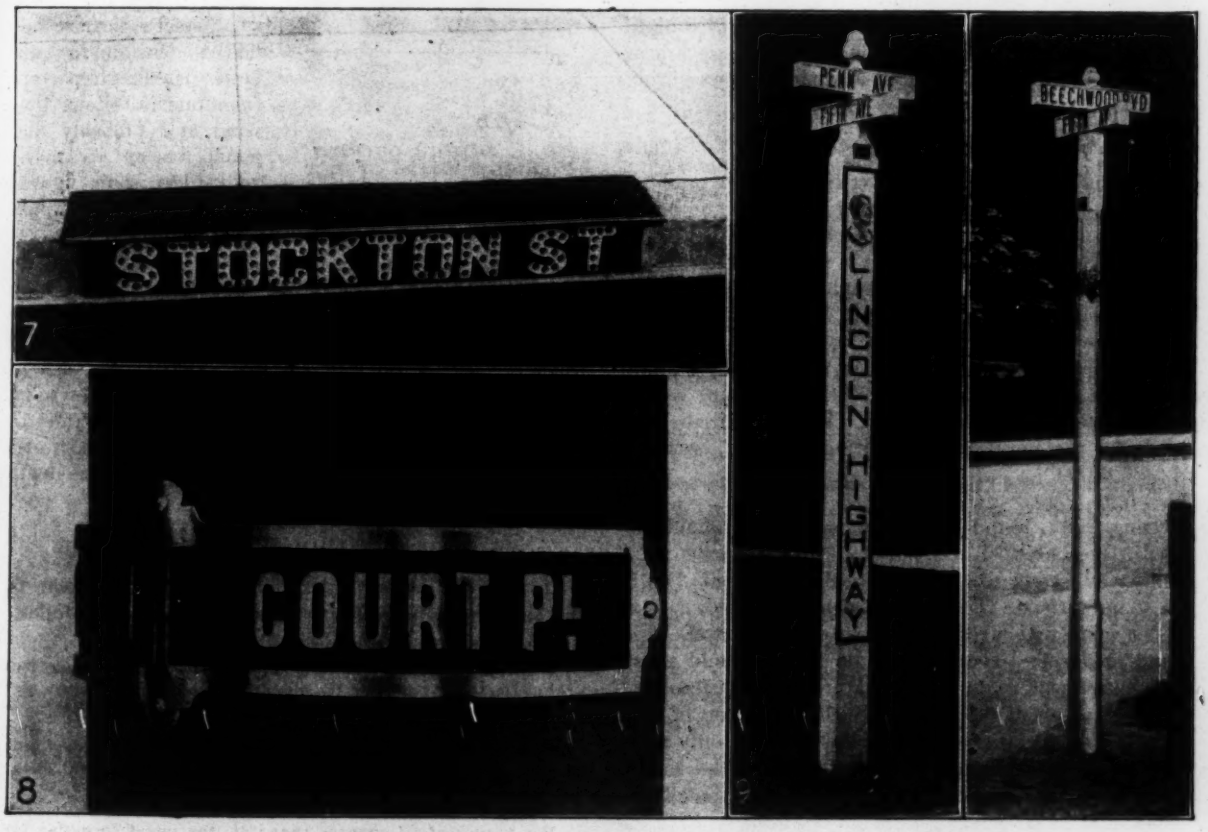
Regular Inspection of Sewers Part of Maintenance

William H. Connell, chief of the Bureau of Highways, Philadelphia, Penn., is a strong advocate of sewer maintenance rather than sewer repairs. As in all the older Eastern cities, the sewers of Philadelphia are wearing out. The following paragraphs from Mr. Connell's recent annual report tell how these old sewers are being kept in service:

The number of complaints on sewer conditions received during the year 1915 were reduced about 15% compared with the three preceding years. There were several reasons, chief of which was the systematic cleaning and inspection of sewers in the central section of the city and the replacing of broken inlets and manhole castings throughout the entire city with standard castings, which are heavier and therefore better adapted to the increasing weight and speed of traffic.

The advisability of periodical inspection and cleaning is best shown through the reduction in the number of complaints in the central district, where the decrease for one year has amounted to 35%. As a result, the year's work was singularly free from extensive reconstructions, which generally follow heavy storms and freshets. These test the sewers to capacity and play havoc with the weak links of the various systems.

During 1915 the systematic cleaning of sewers was undertaken for the first time in the history of the Bureau of Highways, and splendid results were obtained. The entire Arch St. system, including all the sewers in the area from Market to Vine St. and from 13th St. to the Schuylkill River, were thoroughly cleaned and inspected. The size of these sewers varies from 6 in. to 9 ft. 6 in. in diameter, and the total length cleaned at least once amounted to 13.94 mi. Approximately one-half of the Willow St. system, beginning at the intersection of Ridge and Girard Ave., was cleaned once, the total length to Jan. 1, 1916, being 9 mi.



FIGS. 7 TO 9. ILLUMINATED CURB SIGN; BRONZE NAME PLATE; REINFORCED-CONCRETE SIGNS

The sewers in these systems were thoroughly inspected while undergoing the cleaning process, and minor repairs were made where required, so that no serious cave-ins of the sewers have been reported in these two districts this year. This unquestionably demonstrates the value of what might be termed "preventive work in the maintenance of sewers."

The cleaning in itself is not only necessary to insure the proper operation of the sewers and thus prevent the backing up of sewage into cellars and the overflowing of streets, but it provides for a patrol system of inspection that catches the many minor defects of natural deterioration before serious breaks can occur.

Bond and Shear in Reinforced Footing Offsets

By Clifford Older*

Reinforced concrete is now so generally used that designers are sometimes found using the formulas for this material under certain conditions which lead to rather peculiar results. A case in point is that of such footing offsets as prove desirable in the design of many thousands of highway bridges.

As an example, consider the footing outlined in Fig. 1. The soil reaction under the offset O may be represented by the area $ABCD$. Let V equal the resultant of this reaction, y its moment arm, F the thickness of the footing and EC the critical section to be considered.

Assume a footing thickness F of 18 in., a moment arm y of 9 in. and a reaction V of 6,000 lb. Assume also that the t-bars used to reinforce the offset are located 6 in. above the bottom of the footing, because of convenience in placing in wet foundation pits. These are assumptions frequently approximated in highway-bridge design.

Ordinary Formula Shows Excessive Bond Stress

The bending moment at the critical section would be 54,000 in.-lb. Neglecting tension in concrete and applying the usual reinforced-concrete formulas, with $d = 12$ in., $f_s = 16{,}000$, and $n = 15$, it is found that 0.32 sq.in. of steel per lin.ft. of footing would be sufficient. The compression in the concrete would be about 300 lb. per sq.in.; the maximum shear ($d = 12$ in.) 45 lb. per sq.in.; average shear ($d = 12$ in.) 41.5 lb. per sq.in., or average shear ($d = 18$ in.) 28 lb. per sq.in. All of these stresses seem reasonable. The bond stress to be developed per lineal foot of footing, however, would be

$$\frac{jd}{V} = \frac{6{,}000}{0.92 \times 12} = 544 \text{ lb.}$$

Using ⅝-in. round bars 12 in. on centers would provide an area of steel of about 0.31 sq.in., but the maximum bond stress would theoretically be about 277 lb. per sq.in. surface. To keep the bond stress down to 80 lb. per sq.in. without using a great excess of steel, ¼-in. round rods spaced about 1.4 in. on centers would satisfy the requirement as to bond and provide an excess tension area of about 0.10 sq.in. Such a selection of reinforcing steel to satisfy requirements of bond only seems rather absurd, considering the fact that, if the steel is entirely neglected and the offset figured as a homogeneous cantilever beam 18 in. deep, the tension in the concrete would be only about 83 lb. per sq.in., or not more than about one-third of the modulus of rupture that might be expected.

Probable Influence of Concrete Tension

It is evident that when the offset is small as compared with the thickness of the footing, and the steel ratio is low, the concrete stress at C, considering the offset as a plain concrete cantilever, may be well within a safe working stress for concrete in tension, the steel stress only n times the stress in the concrete at the same elevation, and the bond stress very small. As the bending moment increases, the required steel ratio increases also, and the concrete at C will eventually crack. It does not appear, however, that the bond stress increases suddenly from practically zero to the full theoretical amount when the modulus of rupture of plain concrete is exceeded, nor does it appear that the maximum diagonal tension is as great as the total shear at the face of the wall would indicate.

Diagrams showing the position of the neutral axis, as determined by tests, indicate that for small loads the distance from the compressive face to the neutral axis is practically one-half the total depth of the beam, and this distance does not decrease materially, particularly when the steel ratio is small, until the loads are increased to at least one-eighth of the ultimate. The rise of the neutral axis is not abrupt at any stage of the loading. (See "Principles of Reinforced Concrete," by Turneaure and Maurer, 2nd ed., Art. 101.) These diagrams seem to indicate that, particularly when small steel ratios are sufficient, tension in concrete is an important function; it follows that bond and probably diagonal tension are materially less than figured by the usual formulas, at least for loads which would produce a concrete stress less than the ultimate.

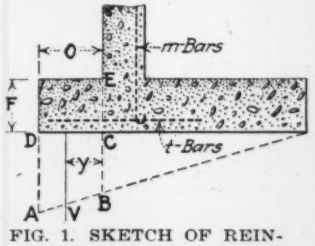


FIG. 1. SKETCH OF REINFORCED FOOTING OFFSET

Tests of wall footings by Professor Talbot (See University of Illinois Bulletin No. 67) indicate very high theoretical bond stresses at maximum loads and but few bond failures. Only four bond failures were reported when the steel ratio was less than 0.0098. In each of these cases the steel stress exceeded 41,000 lb. per sq.in. at failure. In considering diagonal tension, Professor Talbot recommends that the critical section be taken at a distance out from the face of the wall equal to the depth of the footing.

New Illinois Highway Rule on Offsets

In view of these considerations, the Bridge Bureau of the Illinois Highway Department has adopted the following rules governing the design of footing offsets:

Shear, as a measure of diagonal tension, and bond stresses are neglected when the tensile stress in the concrete (f_c') figures less than 75 lb. per sq.in. considering the offset as a nonreinforced cantilever beam.

Shear and bond stresses are considered to increase uniformly from zero at $f_c' = 75$ lb. to the full theoretical shear $\left(v = \frac{V}{bjd}\right)$ and bond $\left(u = \frac{V}{\Sigma ojd}\right)$ at $f_c' = 200$.

For values of f_c' greater than 200, the usual formulas for shear and bond are used.

*Bridge Engineer, Illinois Highway Department, Springfield, Ill.

Tension in concrete is neglected in figuring the area of steel required for tensile stresses as some steel is desirable in any case to aid in anchoring the M-bars of the vertical wall.

In order to facilitate the application of these rules, curves have been plotted for footings of various thicknesses, of which Fig. 2 is an example.

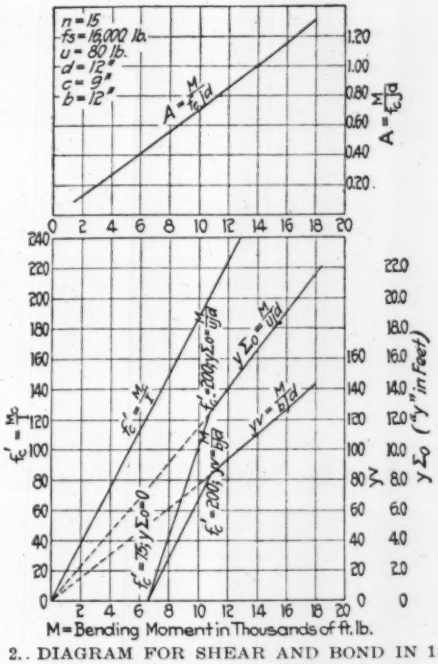


FIG. 2.. DIAGRAM FOR SHEAR AND BOND IN 18-IN. FOOTING OFFSET 12 IN. DEEP

The derivation of the formulas used in plotting these curves is as follows. The notation is the same as that in common use except as noted. Let

y = Moment arm (see Fig. 1);
V = Reaction on offset = total shear;
I = Moment of inertia of critical section, neglecting reinforcing steel;
d = Gross depth F of footing (see Fig. 1);
c = One-half depth of footing = $\frac{1}{2} F$;
fc' = Tension in concrete, neglecting reinforcing steel.

Then

$$f_c' = \frac{Mc}{I} \qquad (1)$$

$$M = Vy; \quad V = \frac{M}{y}$$

$$u = \frac{V}{\Sigma ojd} = \frac{M}{\Sigma ojdy}$$

$$y\Sigma o = \frac{M}{ujd} \qquad (2)$$

$$v = \frac{V}{bjd} = \frac{M}{bjdy}$$

$$yv = \frac{M}{bjd} \qquad (3)$$

Also from (2) and (3) $bvy = uy\Sigma o$ and $yv = \frac{u}{b}(y\Sigma o)$

$$M = f_s pjbd^2 = (pbd) f_s jd$$

$$pbd = A$$

$$M = Af_s jd$$

$$A = \frac{M}{f_s jd} \qquad (4)$$

It will be noted that when the bending moment on the offset has been computed, the area of tension steel (neglecting tension in concrete) and the tension in the concrete (neglecting steel) may be read direct from the diagram. The readings for bond and shear must be divided by y in order to obtain the true value of these quantities. For convenience, the bending moment is given in foot-pounds and y in feet. The curves for $y\Sigma o = \frac{M}{ujd}$ and $yv = \frac{M}{bjd}$ are dotted from the $f_c' = 200$ point to zero in order that the reduction relation may be seen.

In computing the tables from which the curves were plotted, large-scale curves giving values of j and R_s ($= f_s pj$) for various percentages of steel were used.

Duty of Water for Irrigation Under Idaho Conditions*

By Don H. Bark†

The investigations have determined the factors which must be taken into consideration in determining the proper duty for an entire irrigation project. The first factor is the proper duty of water at the land. The results of the investigation indicate that under conditions similar to those obtaining in Idaho a normal project with medium clay loam should furnish sufficient water so that 2 acre-feet can be retained upon each and every irrigated acre during the season; that this quantity should be delivered under a rotation system in heads of such sizes that economical use can be secured; and that where a project is devoted one half to grain and the other half to alfalfa or other crops requiring a similar volume of water, 18.7% of this 2 acre-feet should be delivered during May, 28.3% during June, 32.8% during July, 17.2% during August, and 2% during the first half of September, there being but little need for irrigation during the month of April and practically none after the middle of September, provided stock water or that used for domestic purposes is not taken into consideration. It has been shown that the farmer must receive approximately 2¼ ft. of water per acre at the farm in order for him to retain 2 ft. per acre upon the land. Where projects consist in whole or in part of porous soils or of soils with porous subsoils lying closer to the surface than 6 ft., more than 2¼ ft. per acre should be delivered to the consumers, the quantity required being largely dependent upon the porosity of the soil.

A conservative estimate of the transmission losses should be made in advance for each project, in either cubic feet per square foot of wetted area or per cent. per mile, from the quantity required of canals to furnish sufficient water to all parts of a project. A normal project will be found to lose from 20 to 40% of all water diverted before the water can be delivered to the farmer.

After the duty of water at the land, the size of the project, and the probable transmission losses have been determined, the net area which may be irrigated may be

*Conclusions of Bulletin No. 339, United States Department of Agriculture, "Experiments on the Economical Use of Irrigation Water in Idaho." Copies of the Bulletin may be obtained for 10c. from the Superintendent of Documents, Washington, D. C.

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readily found. It then becomes necessary to calculate the extent of waste or nonirrigated land from all causes which will finally be contained in the project. This, added to the net area which can be irrigated, will give the gross area of the project. The extensive survey that was made for the determination of this factor seems to indicate that 90% of a normal project will be irrigated every year after the project is fully developed.

The investigation has demonstrated the adequacy of 2 ft. per acre for diversified crops on the better class of soils, but it requires careful husbandry to render this quantity adequate, and it seems evident that but few projects will ever exist, with conditions similar to those in south Idaho, where an allotment of less than this supply will be justified. It is believed, however, that the volume of water which will produce the maximum yield of crop on any certain variety of soil is in but few cases the proper and economic duty. It is very evident that the cost of the land, of water, the value of the crops produced, and the cost of producing them, as well as the volume of water which will produce the largest yield, must all be taken into consideration when determining the duty for any project. In many places the largest crop has been produced where the most water has been applied, but the yield has been in but few cases proportional to the quantity of water used, and in view of this there is no doubt that, broadly speaking, one would be justified in opening up a project with a higher duty of water where water is very valuable and land comparatively cheap than where land is high and water comparatively inexpensive.

The determination of the proper supply of water for an irrigation project is a very serious problem and one that must be given the most careful consideration, for it is fully as serious to err on the side of too little water as it is on the side of too much. If too little water is allotted, the farmers never can produce profitable crops and the lands never will reach their highest possible value, while if too much is allotted the ultimate irrigated area is not only cut down, but the excess supply is almost invariably used, resulting in the rapid water-logging and deterioration of the irrigated lands.

Excess Condemnation and City Planning

By Charles K. Mohler*

SYNOPSIS—The principles and advantages of excess condemnation, or the taking of more land than is needed for the immediate purposes of a public improvement, and the subsequent readjustment of lot lines and resale of the excess property are set forth. A number of the arguments are illustrated by examples from a Pacific Coast city.

A serious obstacle to city planning in most states is the lack of adequate methods for acquiring the necessary lands for public use. Excess condemnation has been employed in Europe for over 60 years. In the United States, Connecticut, Massachusetts, Maryland, New York, Ohio, Pennsylvania and Virginia have established the right of "excess condemnation," or the right to take by condemnation land outside the exact bounds of a proposed improvement. The objects in acquiring excess land which may be resold or leased by the governing agency are:

1. To place it under necessary or desirable restrictions.
2. To secure remnants or fractions of subdivisions outside the improvement boundaries.
3. To secure enough additional property outside the boundaries to include, where necessary, in resubdivision.
4. To secure for future use land which may not be needed at the present.

The reasons for these objects should be briefly discussed.

1. Restrictions—In laying out streets, boulevards, parks, playgrounds, etc., the very object of the improvement may be defeated if proper restrictions are not placed on the adjoining property. While the necessary restrictions may be secured in some cases by means of easements, it may prove more advantageous in others to condemn the property and resell under such restrictions as it may be wise to impose. It may be desirable or necessary to exercise the right to abate nuisances.

2. Remnants—Securing remnants (the value of which may and probably has been awarded to the owner from whom the main portion was secured) is a right of the greatest importance. This feature can best be shown and illustrated by a street opening recently undertaken in a Pacific Coast city.

In Fig. 1 the "Proposed Broadway 'Opening'" is shown, made up of the hatched portions *B* and *D* and the portion of an alley marked *C*. Notice the small fractions or remnants left from lots 4, 5, 34, 32 and 30. Lots 6, 7, 8, 21, 22 and 24 are left facing unimportant cross-streets. Lot 22 is left too narrow for proper development, and the alley east of lot 24 will prevent joining to the lots on the east, to secure the best use. With the opening completed, the old portion *EE* of Broadway would be rendered practically useless and as a result should be vacated and thrown into the resubdivision. Lots 6, 7, 8 and 21, while assessed for benefits, are not in such position as to derive the full amount that should be possible through resubdivision. Under the present status the municipality is powerless to effect any change from such conditions as described, and as shown in Fig. 1.

The most successful method of handling remnants appears to be that worked out and used in France. Where remnants are too small for proper development, they are acquired by the municipality. The parcels are then carefully and impartially appraised and the owner of the adjoining property given the opportunity to purchase at the appraised value. If the owner of the adjoining property does not purchase within a specified time, the municipality may then proceed to take over his property, combine it with the remnant and resell the whole.

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The futility and evil effects of leaving wedges or remnants in the hands of private owners without any power of control by the governing agency is well illustrated by Figs. 3 and 4. In Fig. 3 the "old" street is shown on the left and the "opened" street on the right with the remnant in between occupied by a brick wall that serves the purpose of an advertising billboard. The pleasing billboard effect is seen in Fig. 4. At the extreme left of Fig. 4 is the end elevation shown in Fig. 3. Fig. 5 shows the general layout of the old and "opened" streets and the remnant left between the two public thoroughfares.

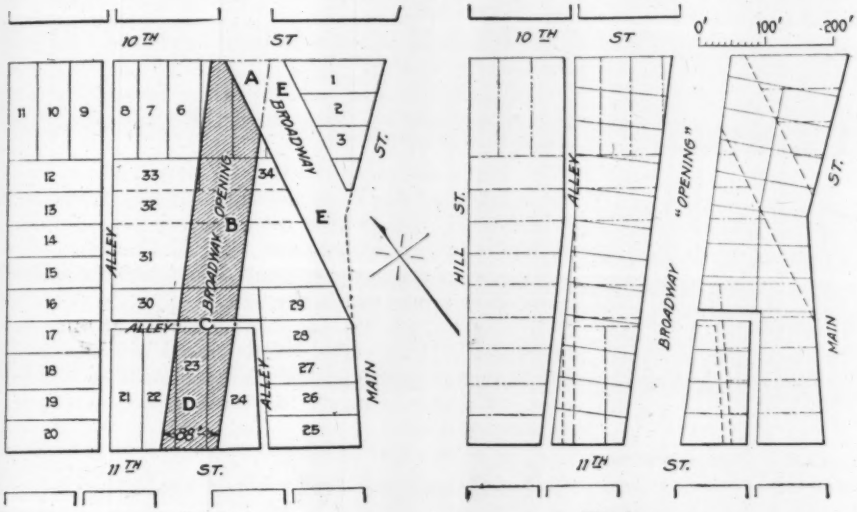

Fig. 1 Fig. 2

FIGS. 1 AND 2. EFFECT OF STREET OPENING ON LOTS, LOS ANGELES, CALIF., AND POSSIBLE SUBSTITUTE

Fig. 1—Ordinary method as carried out. Fig. 2—Excess condemnation possibilities

Again referring to Fig. 1, observe the long wedge-shaped remnant left from lot 5, facing on 10th St. The award for the portion of lot 5 taken was fully equivalent to, if not greater than, the fair value of the entire lot; but still the remnant is left in possession of the original owner. In addition to the possibilities of billboard development, such as just illustrated, it may stand as an effective barrier to the proper development to secure the best results from the "opening" improvement.

The valuable frontage in the case under consideration is on Broadway. That would call for the merging of lots 6, 7 and 8 and the remnant remaining from lot 5. Lots 6, 7 and 8 have been assessed benefits, and naturally should be given the opportunity of getting the best returns. If the owner of the remnant does not choose to come to some reasonable agreement with the other owners, nothing can be done unless the others submit to a "hold-up." As the remnant has already been paid for, why should it not be taken by the municipality and devoted to the good of all concerned? The only use the wedge can serve by itself is for the location of an advertising fence and a possible "stand" of some sort.

3. Resubdivision—Under remnants, just considered, one feature of resubdivision was touched upon. The question is one of far-reaching importance. Again referring to Fig. 1, a glance will show how far the "improvement" will fall short of the possibilities, if the entire situation is left as shown. The desirable, if not necessary, changes to make are the following:

A. To throw lots 6, 7 and 8 and the remnants of lot 5 together and replot so as to get the valuable Broadway frontage.

B. To vacate the portion of Broadway marked *EE*, to combine with lots or portions of lots 1, 2, 3, 4, 34, 32, 31, 29 and 28, for an entire rearrangement in subdivision.

C. From the south line of lots 13 and 32, to change the location of the alley west of Broadway to bring the south end out opposite the alley south of 11th St.; to close the portion of the east and west alley lying between Broadway and the north and south alley just mentioned and use it for resubdivision. This will give the twofold advantage of Broadway frontage for lots 21 and 22 and equalize the depth of lots lying between Broadway and Hill St.

D. To relocate the alley between Broadway and Main, midway between the two, to secure depth for the Broadway frontage of lot 24 and equalize the lot depth between Broadway and Main.

Fig. 2 shows a possible resubdivision in accordance with the foregoing requirements. Old subdivision lines are shown with a dash and dot, and old street lines in short

FIGS. 3 AND 4. REMNANT AND WALL LEFT IN LOS ANGELES STREET WIDENING AND STRAIGHTENING (SEE FIG. 5)

End view of wall, new and old streets, looking south. Side view of wall and use to which it was put

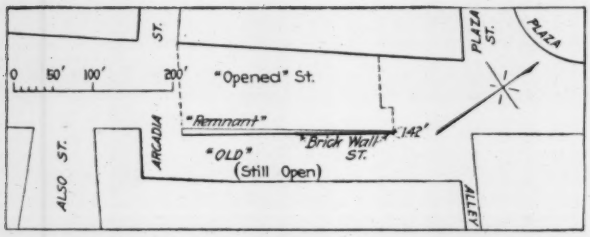

FIG. 5. PLAN OF STREET WIDENING AND STRAIGHTENING SHOWN IN FIGS. 3 AND 4

dashes. New subdivision and unchanged lines of streets are solid. The advantages gained are briefly:

A. The valuable Broadway frontage is secured throughout.

B. The old and useless portion of Broadway is vacated and made available for use, so that instead of being left with five small remnants, ten large well-shaped lots are secured.

C. West of Broadway all lot lines are at right angles to the street line. East of Broadway the deviation from right angles of the lot lines is equally divided between Broadway and Main. This gives better intersection angles on both streets than the old subdivision lines.

D. As before stated, the change in the location of the alleys on each side of Broadway gives equal depths of lots between Broadway and Main and Broadway and Hill. The alleys are also brought out opposite the alleys south of 11th St.

E. All long, narrow, thin, wedge-shaped and fractional portions of lots are eliminated and lots of usable size and shape are obtained instead. This is a very important object to accomplish.

F. The amount of land added and made available for sale by the vacation of that portion of Broadway and the alley rendered useless, together with the replotting of the entire tract effected, should increase values for resale enough to pay for the improvement, if not actually return a profit.

4. Land for Future Use—Where only such land can be acquired by condemnation as is required for immediate use, it may prove a serious handicap where future developments need more land than can be used at the time the improvement is first undertaken. Generally when public improvements are made, the surrounding property at once increases in value. Occupancy and speculation may so increase values that, when additional development is undertaken, the necessary land may cost many times what it would have cost if acquired under the first proceeding, if in fact it can be obtained at all. Sites for parks, playgrounds, schools, public buildings, etc., are cases in point. Some advocate the purchase of the major portion of the surrounding property, which would benefit by the improvement, by the municipality for resale or lease, in order to realize on the increment in value. Under proper safeguards this would be advisable in some cases.

It is needless to state that much of the property, if left as shown in Fig. 1 on the old subdivision lines, will be of little if any value.

It may be pertinent to call attention to several misconceptions about excess condemnation.

1. In Favor—(a) Some believe it will afford a means of paying for an improvement, or even return a profit, by the resale of land taken. This may or may not be the result and should be considered as merely incidental in most cases. Returns from resale should not be counted in any sense as the "object" in undertaking an improvement.

2. Against—(b) The fear is entertained by some that the right to take excess land will result in the municipality undertaking improvements for the purpose of exploitation or speculation.

(c) Others seem to fear that the governing agency might undertake improvements and acquire so much land as to go bankrupt.

These two negative misconceptions are founded largely on the affirmative one, where "returns" from resale are "expected." When an improvement is undertaken because of its need or inherent merits and excess land is acquired for any of the objects—restriction, securing remnants, resubdivision, land for future use as above specified—there should be little danger of either speculation or bankruptcy.

The fear is also expressed that the person whose property is taken outside of an improvement may be injured or exploited. The process for acquiring property outside the improvement boundary will be the same as for that inside and a party affected should suffer no more injury in one case than in the other.

Cities have so increased in size, population and importance that every reasonable facility should be made available to correct past mistakes and to provide for future needs. Working methods for this purpose have been too long neglected.

Influence of Viscosity in Pumping Crude Oil

By Arthur L. Collins*

It is the intention here to emphasize the importance of the viscosity factor in the design and operation of pipe lines rather than the gravity of the oil. The article by C. P. Bowie, on "Pumping California Crude Oils," in *Engineering News*, Dec. 2, 1915, treats of the oils registering 16° Bé. and over. Pipe lines that transport oil with a viscosity practically the same as that of water for all temperatures offer no particular difficulties. The data obtained on lines where the viscosity of the oil is greater than that of water have always been of little importance to the designing and operating engineer, because there has been no reliable way to measure this so-called viscosity. It can be shown that without this factor, better termed "friction characteristic of the oil" rather than viscosity, there can be no accurate basis for design and operation.

For two years the writer has devoted his time almost exclusively to the study of oil friction in pipe lines. The object has been to establish a scientific method for locating pumping stations for new lines, a method which will also insure the making of repairs and improvements intelligently. Lines now operating can then be made to operate more economically and satisfactorily by knowing in advance how the oil will act under different climatic conditions.

In July 1914, E. I. Dyer, of the Union Oil Co., prepared a paper for the American Society of Mechanical Engineers, in which he said:

Unless the loss of head by friction can be predetermined with reasonable accuracy, every element entering into both

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the first cost and the operating costs of the installation is uncertain; and should the design be undertaken in an era of keen competition and small margins of profit, a losing venture might easily result. . . .

The most economical pipe line for a given service cannot be determined in advance without a working knowledge of the laws governing the flow of oil in pipe lines in general. The determination of these laws offers the most important single problem in pipe-line work.

In considering what is meant by the word viscosity the writer wishes to dispel a general impression that the specific gravity or relative weights of the different oils is a measure of the respective viscosities. The lighter products of the crude oils run to gasoline and the heavier products to asphaltum or the base. The former may be said at times to be more thin, or viscous, even than water. The latter may be of all degrees of consistency and are known as heavy oils. It may be said to be a coincidence that the light crude oils have a thin consistency and the heavy crude oils are thick.

It is possible to select certain lubricating oils as the product of the crudes and have the general rule as mentioned reversed. Thus a 25° Bé. (specific gravity, 0.9032) may have a greater, or rather thicker, consistency than, say, an 18° Bé. (specific gravity, 0.9459).

Generally, when a California crude oil measures around 15° Bé. its consistency becomes not unlike that of molasses at the normal temperature. At 25° Bé. the oils may not be dissimilar to water with reference to their friction characteristics. It is, however, very important to bear in mind that two oils, say of 15° Bé. or lower, may vary almost any amount in their friction values at the same temperatures and within the limits of the temperatures as determined by climatic conditions. By mixing a small percentage of the lighter oils with the heavy oils the viscosity of the latter may be changed to a remarkable degree. Then, in order to handle any given oil, the formula that takes into consideration the gravity of the oil when a viscosity, or, better termed, friction factor, is the one required, cannot be considered very seriously in oil pipe-line work.

The formula developed by Mr. Bowie (*Engineering News*, Dec. 2, 1915) barely reaches the class of oils for which more scientific knowledge must be obtained in order that pipe lines may be constructed and operated to the best possible advantage. The lowest value of C as given in his formula is for a 16° Bé. oil. It would not be considered advisable to attempt a formula such as is given where the gravity of the oil appears as the friction factor.

The oil pipe line as it exists today is the result of cut-and-try methods with what may be termed a wide variation in the safety factor. The meaning of factor of safety as used here by the writer is the reserved pressure in excess of that required for the pumping of water for any given capacity. Economical pipe-line design means the saving of as much as possible of this required excess equipment. Economical operation requires not only a saving in fuel and wear and tear on the machinery, but a maximum quantity of oil pumped.

The absence of an easily operated "oil machine" that will determine the friction characteristics of an oil will account in part for the absence of data on friction flow. The ordinary types of viscosimeters in which the oils must pass through an efflux tube of capillary size are useless for this purpose. Attempts to connect the results of laboratory work with the field work when using California oils have never been satisfactory. To this factor can be traced the lack of sympathy for research work along these lines by the oil companies.

In the article by Mr. Bowie reference was made to the first pipe line constructed in California for the transportation of the crude oil, testing 14° Bé., as obtained in the Kern River fields. As it is the intention to give here also data on the "safety factor" of oil lines, the following is noted regarding this "rifled pipe line" (from *Engineering News*, June 7, 1906, and *Journal of Electricity, Power and Gas*, Oct. 3, 1908):

Cost, about $5,000,000.
Length, 282 mi. Diameter of pipe, 8 in.
Pumping stations, 24 mi. apart.
Capacity, 17,000 to 20,000 bbl. per 24 hr. of net oil.
Pressure on pumps, 750 lb. per sq.in.

In the line is inserted 10% of water to form the water film around the oil. The formula that applies to the capacity and pressure of the line is $p = \frac{Kv^2}{d}$, where

p = Fall in pressure for 100 ft.;
d = Diameter of pipe;
v = Velocity;
K = Constant.

K changes as follows: For 8-in. pipe not rifled (with oil)—straight pipe—oil—no water, average, $K = 7$; 90% oil and 10% water, best value of $K = 4.1$. For 8-in. pipe, rifled (with oil)—90% oil and 10% water, average, $K = 0.49$; 90% oil and 10% water, best value, $K = 0.37$. For 8-in. pipe, rifled (straight water)—average, $K = 0.18$. With these data at hand it is desirable now to obtain the pressure as given by these values for the comparison.

Assume the capacity as 24,000 bbl. (1,008,000 gal.) per day. The velocity in the pipe is about 4.45 ft. per sec. When $K = 0.18$, the pressure is 23.5 lb. per sq.in. When $K = 0.37$, the pressure is 48.3 lb. per sq.in. When $K = 0.49$, the pressure is 64 lb. per sq.in. per mi.

This formula gives a value of 23.5 lb. per sq.in. per mi. for water, but for convenience the writer wishes to use the value of 25 lb. per sq.in.—which can be justified by the formula for ordinary plain pipe.

The 64 lb. can be provided in the spiraled line only by making the stations 12 mi. apart rather than the 24 mi. as planned. If the stations are 12 mi. apart and it is desired to discharge 24,000 bbl. per day, there will be required a safety factor of $\frac{64}{25}$, or 2.56, as determined by the formula. It is quite evident from the factors where K is from 4 to 7 that some treatment of the oil is absolutely necessary; otherwise the pressure would be several times greater than is permissible.

It may be noted here that the other oil lines have not been duplicates of the rifled system. Another point worth mentioning is the fact that the first lines with the "hot system" have the pumping station 12 mi. apart. The reason may be more than a coincidence, since they have all been constructed by empirical methods.

The data given by Mr. Bowie on p. 1070, *Engineering News*, Dec. 2, 1915, no doubt have reference to the "hot method," in which the viscosity of the oil is changed by heating.

As has been mentioned before, the value 16° Bé. is a variable quantity when given as a measure of viscosity,

but Mr. Bowie's indicated value of C will be used for the second comparative example.

$$Q = C\sqrt{\frac{P}{Le}}$$

where

Q = Quantity of oil in barrels per hour;
C = Constant;
P = Initial pump pressure in pounds per square inch;
L = Length of line;
e = Factor dependent upon the size of the pipe used (for 8-in. pipe is 1).

For 16° Bé., C is 160. P is then 39 lb. per sq.in. per mi.

It should be remembered that this value is the pressure on the pumps. In the first mile out from the station the pressure of the oil may not be more than that of water, but the last mile may be several times that of water, due to the cooling of the oil. The formula gives an integrated value of 39 lb. per sq.in. per mi. for a line 13.1 mi. long. In practice it may be necessary to space the stations all the way from, say, 5 mi. to 25 mi. apart, depending upon the character of the country. The viscosity of the oils testing 17° Bé. and lower is very erratic; and it has been impossible, as far as the writer knows, to obtain an assignable measure of the friction characteristics on any laboratory instrument. The permissible average pressure on a station of 13.1 mi. is 800 lb. divided by 13.1, or 61 lb. The line would have a safety factor of $\frac{61}{25}$, or 2.44. Using the derived value of 39 lb., there would be required a factor of safety of $\frac{61}{39}$, or 1.56.

By the experiments of the writer it had been concluded that the 25° Bé. oil gives a value practically the same as water, which is borne out by comparing the value of C as given by the formula of Mr. Bowie.

The following data are from the Valley pipe line (Shell Co.), recently constructed (*Journal of Electricity, Power and Gas*, September, 1915):

Cost, about $4,000,000.
Length, 170 mi.
Two-thirds of the pipe is of 8-in. diameter.
One-third of the pipe is of 10-in. diameter.
Capacity is 25,000 bbl. per 24 hr. of 16° Bé. oil.
Stations, 15½ mi. apart.

Let it be assumed that the water pressure for 24,000 bbl. per day is 25 lb. per sq.in. per mi. for 8-in. pipe and the pressure for the 10-in. is one-third of that value, or 8⅓ lb. per sq.in. The average pressure then is 19.5 lb. per sq.in. instead of 25 lb. The permissible pressure is 800 lb. at the pumps. The pressure is 51.6 lb. per sq.in. per mi. The factor of safety is $\frac{51.6}{19.5}$, or 2.65.

The important feature as pointed out in this recently constructed line is that, as custom had established the distance between stations as about 13 mi., an improvement had been made by increasing the distance to 15½ mi., offsetting the increased pressure due to the added cooling of the oil and resulting increase in pressure due to viscosity, and saving one pumping station. The saving is estimated at $250,000 in the first cost, as the difference between the $300,000 station and $50,000—the latter being the difference in cost between the 8-in. and 10-in. pipe. This factor of safety can be estimated in dollars. In the foregoing example, to pump water only would require five stations. Then it has required, to take care of the safety factor, six stations aggregating $1,800,000. There is then $1,800,000 out of the total of $4,000,000 which is left to the judgment of the engineer for distribution and expenditure with indefinite data as a basis for the designs, granting that there is no reliable way by which the friction characteristics of the oil to be handled can be accurately measured.

For the summary we have:

Rifled Line:	
Capacity, 24,000 bbl., including 10% water, stations 12 mi. apart.	
Safety factor, by allowable station pressure	2.50
Safety factor by formula, as necessary	2.56
Associated Line (by Mr. Bowie):	
Capacity, 24,000 bbl.	
Safety factor by allowable station pressure	2.44
Safety factor by formula, as necessary	1.56
Difference	0.88
Shell Line:	
Capacity, 24,000 bbl.	
Safety factor of construction	2.60

After considering the improved method of the Shell Co. with reference to the combination of the 8- and 10-in. pipe the engineer no doubt will ask: If it may be considered good practice to increase the length between stations from 14.17 mi. to 15.45 mi. in a line 170 mi. long and in so doing save $250,000, why not increase this distance another 1½ mi. and save a like amount or thereabouts?

The question is likely to remain unanswered until the friction characteristics of the oil that is to be handled are better understood by those to whom the work of constructing and operating the line is intrusted.

Pipe lines, and particularly those which are heated, deteriorate very rapidly. It has been said that the life of the pipe line should be considered as 10 yr. These lines sooner or later, and some of them in the near future, must be completely or in part reconstructed. Again, the demand for capacity on the pipe lines is going to increase rather than decrease.

The oil industry has been allowed to develop with those in charge of the operations little appreciating the value of using the friction characteristics of the oil rather than the gravity, in the solution of their transportation problems, for no other reason than the absence of a better system of grading the oils. Inasmuch as it has been stated that the capacity of a line is determined by its weakest point, the proper grading of the oils for minimum friction qualities will eliminate the peaks of high pressure and cannot help but improve operating conditions.

Electric Traction a Success on C., M. & St. P. Ry.*

The first electric locomotives of the Chicago, Milwaukee & St. Paul Ry. were placed in service on the Three Forks-Deer Lodge division in the Rocky Mountains, Dec. 9, 1915, and electric operation has been maintained since then. Complete success of the new system is reported by the railway officials. In April of this year service was extended to Harlowton, making a total of 220 mi. of electrically operated line. By November, 1916, it is expected that steam traction will be abandoned over the

*From information furnished by the General Electric Co., Schenectady, N. Y., maker of the electrical equipment noted herein.

entire proposed stretch of 440 mi. between Avery, Idaho, and Harlowton, Mont. (four engine divisions). The general engineering features in connection with this project have been described in *Engineering News* (Jan 7, 1915).

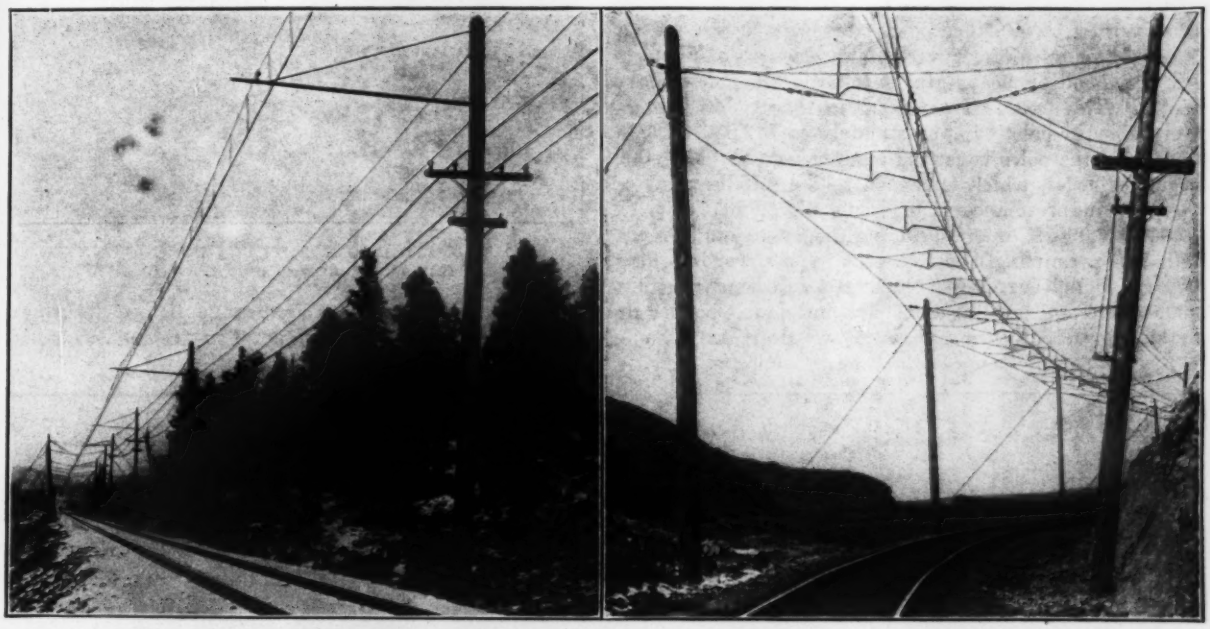
This section is now the longest stretch of trunk line under electric traction in the world. It is the only line where electric locomotives are operating over more than one engine division. The main continental divide is crossed, giving the severest service conditions possible on the entire system of the railroad. In crossing the three mountain ranges included in the electric zone there are several grades of 1% or more, the most difficult of which is the 21-mi. 2% grade between Piedmont and Donald. The longest grade is the 49-mi. 1% grade on the west slope of the Belt Mountains. The curvature is heavy, the maximum being 10°. There are in all 36 tunnels, the longest of which (1½ mi.) is under St. Paul Pass, through the Bitter Root Mountains.

Passenger and Freight Service

The passenger service is comparatively light, consisting of two all-steel transcontinental and one local train in each direction daily. It has been found that on the attractions of the line for tourists. The local passenger train in the electric zone is handled by a half-unit locomotive.

A large part of the freight traffic consists of through trains made up of an assortment of foreign cars weighing from 11 to 25 tons empty and 70 tons loaded. These are equipped with air brakes variously adjusted for different conditions of service, making the problem of holding long trains on heavy downgrades difficult with air alone. But with the electric locomotives regenerative braking has been resorted to with general success—the locomotive motors become generators and return power to the line, the air brakes being released and held in reserve.

In the freight service on the first division, where steam locomotives require 10 to 12 hr. to make 115 mi., the electric locomotives need a schedule of only 7 to 8 hr. for the same distance. The heavy grades and curves have always offered a serious obstacle to steam-locomotive operation even in summer time, and in winter serious delays have occurred owing to engine failures. In December, 1915, several Mallets were frozen up at different points on the system, and the new electric equipment was rapidly pressed into service to replace them. On several occasions the electric locomotives hauled in disabled steam



FIGS. 1 AND 2. OVERHEAD 3,000-VOLT LINE CONSTRUCTION, ELECTRIC-TRACTION ZONE, C., M. & ST. P. RY.
Fig. 1—Tangent bracket construction. Fig. 2—Cross-span, pull-off and feeder-tap construction on a 10° curve

21-mi. 2% grade between Piedmont and Donald the electric locomotive can reduce the running time from 1 hr. 5 min. to 40 min. The run from Deer Lodge to Butte has been cut from 1 hr. 20 min. to 50 min. The four through passenger trains (the "Olympian" and the "Columbian") are taken across the two mountain ranges by a single passenger locomotive. These trains consist of eight vestibuled steel coaches weighing 660 tons. Instead of changing locomotives at Three Forks as before, the same locomotive is run through the 220 mi. from Deer Lodge to Harlowton, changing crews midway. The entire electrified division will be covered by passenger trains in approximately 15 hr., including all stops, increasing the engines and trains that would have otherwise tied up the line and interrupted the service.

Power-Supply System

Trains of 3,000 tons trailing load have been hauled east and 2,800 tons west, using a helper on the heavy grades. All passing tracks are being lengthened to take advantage of longer trains, which are now possible with electric traction. On some runs, where the grades are less than 1%, trains of up to 130 cars and as heavy as 4,000 tons have been hauled by a single unit.

It should be mentioned in passing that the scheme of electrification includes the generation of power at several

hydro-electric stations of the Montana Power Co., its transmission by 100,000-volt three-phase 60-cycle current, its conversion in substations to 3,000-volt direct current and its distribution over catenary overhead construction to the electric locomotives. The power company's transmission lines are carried on steel-tower and wooden-pole lines and tap into the railway system at seven different points. The railway company has a transmission line extending the entire length of the system on wooden poles. Each substation may be fed from either direction and also at the tie-in points from a third source of power. There are 14 substations distributed along the route at average intervals of about 32 mi. Each station contains stepdown transformers, motor-generator sets, switchboard and necessary equipment. The 100,000-volt current is first stepped down to 2,300 volts for the synchronous motors, each of which drives two 1,500-volt direct-current generators connected permanently in series.

The overhead construction is comparatively simple. There are two No. 0000 copper wires, flexibly suspended side by side from the same steel messenger cable by independent hangers alternately connected to each wire. Bracket supports are used where the track alignment will permit; cross-span construction is used on passing tracks, switching yards and sharp curves. All the overhead work is supported on 40-ft. wooden poles suitably guyed. A 500,000-circ.mil feeder runs the entire length of the electric zone, and on heavy grades there is a supplementary feeder. The feeders are tapped to the trolley wire at every seventh pole, or approximately each 1,000 ft. On the top of the poles is carried a supplementary No. 0000 negative feeder, which is tapped to the middle point of every second reactance bond (coils placed in the track 5,000 to 6,000 ft. apart, bridging insulated joints in the rails and permitting direct current to pass, but impeding 60-cycle signal currents). Each track is bonded with a 250,000-circ.mil bond at each joint and double bonded on heavier grades to prevent excessive drop in voltage.

Two types of locomotives have been developed—main-line and switching. The main-line locomotives are constructed in two half-units intended to be permanently coupled together; but the halves are duplicates and each is capable of independent operation. The only difference between passenger and freight units lies in their gear ratios and minor auxiliaries. The freight locomotive

FIG. 3. OVERHEAD CONSTRUCTION IN TUNNELS
Collapsing hangers give flexibility

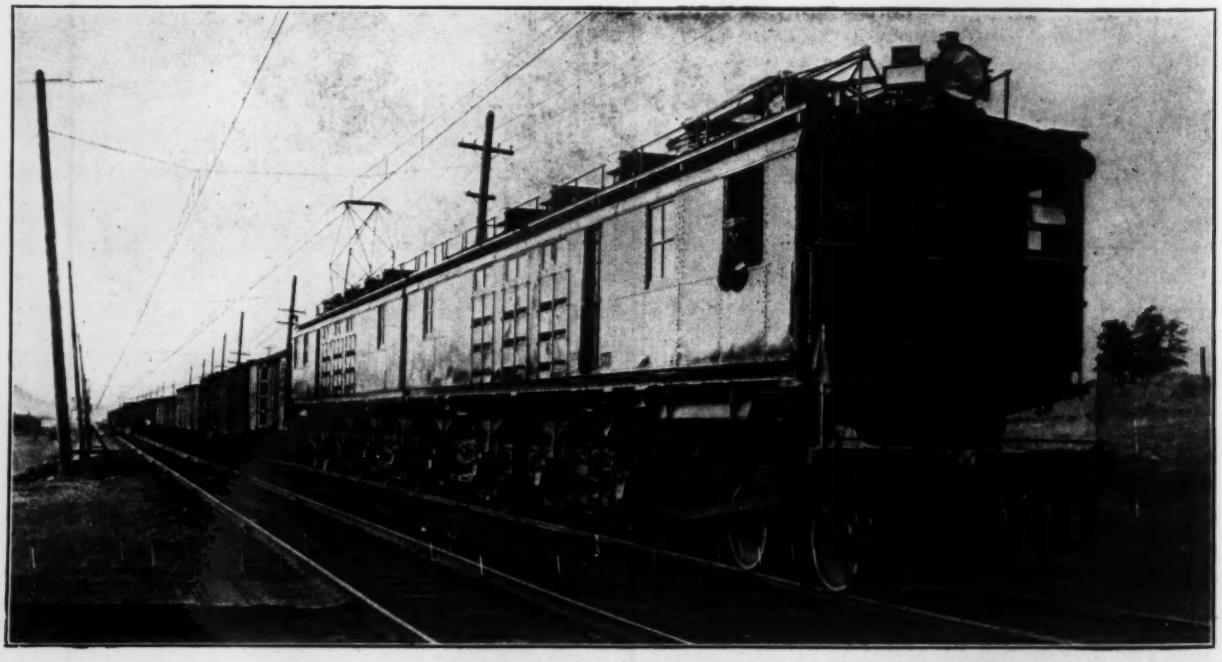


FIG. 4. ONE OF THE 3,000-HP. ELECTRIC LOCOMOTIVES OF THE C., M. & ST. P. RY.

DATA ON C., M. & ST. P. RY. 3,000-VOLT ELECTRIC LOCOMOTIVES

Main-Line Freight Locomotives

Length overall	112 ft.
Total wheel base	102 ft. 8 in.
Rigid wheel base	10 ft. 6 in.
Total weight	564,000 lb.
Weight on drivers	448,000 lb.
Weight per driving axle	56,000 lb.
Weight per guiding axle	29,000 lb.
Diameter of driving wheel	52 in.
Diameter of guiding wheel	36 in.
Number of driving motors	8
Total output (continuous rating)	3,000 hp.
Total output (1-hr. rating)	3,440 hp.
Tractive effort (continuous rating, 15.75 mi. per hr.)	71,000 lb.
Per cent. of weight on drivers (trac. coef.)	15.83
Tractive effort (1-hr. rating, 15.25 mi. per hr.)	85,000 lb.
Per cent. of weight upon drivers (trac. coef.)	19
Tractive effort starting (30% coef.)	136,000 lb.

Switching Locomotives

Length inside knuckles	40 ft.
Height over cab	13 ft. 10 in.
Height—trolley down	16 ft. 8 in.
Width overall	10 ft.
Total wheel base	29 ft. 4 in.
Rigid wheel base	8 ft.
Diameter of wheels	40 in.
Weight—locomotive complete	140,000 lb.
Weight per driving axle	35,000 lb.
1-hr. rating of locomotive	542 hp.
Tractive effort (1-hr. rating, 12 mi. per hr.)	18,400 lb.
Tractive effort (continuous, 13.2 mi. per hr.)	13,480 lb.
Tractive effort, starting (30% coef.)	42,000 lb.

weighs 282 tons, has a starting tractive effort of 136,000 lb. and 85,000 lb. running at normal speed. These figures are to be compared with a weight of 278 tons for the Mallet steam locomotives, which have been relieved and which had a tractive effort of 76,200 lb. At this time 42 main-line units are in service—30 freight and 12 passenger. Each is equipped with eight 1,500-volt motors insulated for 3,000 volts to ground. The motors' normal 1-hr. rating is 430 hp.; the continuous rating is 375 hp. Each motor is twin-geared to its driving axle. The motor has commutating poles and provision for forced ventilation from a blower in the cab. The pantograph shoes are of copper.

The control equipment is of the familiar multiple-unit type; the main control switches are mounted in steel compartments inside the cab with inspection and repair aisles. In each half of the locomotive are a motor-driven air compressor and a motor-generator set furnishing low-voltage current for control circuits, headlights, cab lighting and for charging storage batteries on passenger coaches. (Under steam operation the charging current for these batteries was furnished by a steam-turbine generator set on the locomotive.) This same motor-generator set drives the blower for ventilating the traction motors. On the passenger locomotives are oil-fired steam boilers for heating the cars.

The electric regenerative-braking apparatus automatically controls the speed by regulating the amount of energy put back into the line. The usual speed of a freight train electrically hauled is 15 mi. per hr. ascending, and 17 mi. per hr. descending maximum grades, but with half these speeds the braking can be maintained if required. In case there are no other trains between substations to absorb the power returned to the line by a descending train, this power passes through the substation machinery, is converted from direct to alternating current and fed into the distribution system of the power company. Credit is given for all energy thus returned. The power returned by a 2,500-ton train, running at 17 mi. per hr. down a 2% grade, is about 4,700 hp. In addition to the elimination of difficulties due to the use of air brakes and the prevention of brake-shoe and wheel wear there has been a saving of about 15% in power.

This change from steam to electric traction will cost about $12,000,000. The investment is expected to be self-supporting, through savings in operating expense. C. S. Goodnow, Assistant to the President of the Chicago, Milwaukee & St. Paul Ry., is engineer in charge of the work.

Inspecting Bituminous Road Materials at Refineries

The Bureau of Highways of Philadelphia, Penn., of which William H. Connell is chief, has for over a year been extending its inspection service to the plants and refineries where the materials to be used in bituminous roadwork are manufactured. In his recent annual report on the work of the bureau Mr. Connell states that while it has been customary with many organizations dealing with highway work to inspect or test batches of completed materials at refineries to determine in advance of shipment that they conform satisfactorily to the requirements of specifications, the work of this bureau has made an important step in advance of this by specifying that an inspector should be present during the entire process of producing and combining the materials used, thus making it possible to secure samples of the ingredients as well as of the completed mixture and to determine the method and proportions of combination.

These inspectors made such tests at the plant or refinery as were necessary to control the general character and the consistency of the products, while complete tests on both the ingredients and mixtures were made in the municipal laboratories. It is possible by this means for the city to make complete studies of the desirable properties of such materials and of the variations that should be made in the finished product to suit local conditions rather than to leave these points almost entirely in the hands of the manufacturer, as has largely been the case in the past.

A Ten-Story Building as a Bridge Approach is to be erected by the City of New York on Blackwell's Island, adjoining the Queensboro Bridge. A number of the city institutions are located on the island, approach to which has hitherto been only by boat, although the large bridge crosses the island some 140 ft. in the air. The new building will house some of the necessary institutional services and will contain freight elevators capable of carrying a 5-ton motor truck from the island to the bridge level. Boat service to the island will then be discontinued.

Powdered Coal as Fuel for Locomotives was first tried as long ago as 1901-02, on an engine of the Manhattan elevated railway in New York. The merit of this system of combustion was demonstrated, but its use was not extended, as the means of pulverizing and handling the fuel and controlling the fire were unsatisfactory. In 1914 the New York Central R.R. equipped an engine of the 4 : 6 : 0 class for experimental work. In 1915 the Chicago & Northwestern Ry. equipped a passenger engine of the 4 : 6 : 2 class, which is now in regular service between Chicago and Milwaukee. Early in 1916 the Delaware & Hudson Ry. adopted pulverized fuel for a 145-ton freight engine of the 2 : 8 : 0 class, and installed a plant for drying, pulverizing, storing and supplying the fuel both for locomotives and for stationary boilers, using the waste tailings from anthracite culm banks. The Missouri, Kansas & Texas Ry. is installing a similar plant to supply pulverized coal for both locomotives and stationary boilers. A number of other railways are considering the matter, and the Central Railway of Brazil has decided to adopt the method, after extensive investigation of the work and experience in the United States. This information is taken from a report presented at the annual meeting of the International Railway Fuel Association, held at Chicago, May 15-18. The committee is of opinion that the efficiency of the system has been demonstrated and that there will be marked progress in its use with bituminous and anthracite coals and lignite for locomotives and stationary power plants.

Field and Office

Earth Handled Cheaply in Grading Utah Roads

Graders handled by gasoline tractors moved earth at a cost of 7.5c. per cu.yd., in Utah road work. This is the average cost, the best record being 3.8c.

Grading on Western prairies is not heavy work. The roads follow approximately the contour of the ground, and except for cutting down low humps and filling slight depressions the grading consists merely in opening ditches and crowning the roadway. The earth to be moved in the average highway can be taken to comprise the two triangular ditch cross-sections (Fig. 1) each 4 ft. wide by 1 ft. deep. Thus, the total excavation per mile is 782 cu.yd., or about 1,000 cu.yd. in 1¼ mi. The last named distance was that covered each day by the machine outfit illustrated in the views; the cost per day being $75.

The best record was 2½ mi. per day. This is not for resurfacing an old road, but for grading a new road across comparatively level ground.

The construction of the Midland trail in Box Elder County during the last two years is a good example of this tractor-grader method of construction. Long stretches of a 100-mi. highway were graded for from $30 to $60 a mile. The territory passed through was practically all virgin soil, much of it covered with a heavy growth of sage brush.

Scheme of Shallow Grading

The first step is to mark plainly the outside lines of the ditches. This is done by placing flags at intervals so that the tractor operator can follow the proper line by ranging in the flags with one or two markers on his machine. The tractors used vary, since most of them are

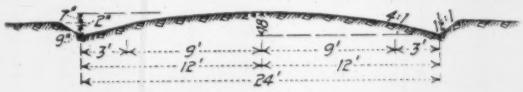


FIG. 1. CROSS-SECTION OF STANDARD EARTH ROAD, UTAH STATE HIGHWAY DEPARTMENT

hired (with the crews) by the day. A 50-hp. gasoline tractor has given the best service.

Coupled to the tractor is a standard 10- or 12-ft. road grader of extra-heavy construction. The first cut is made

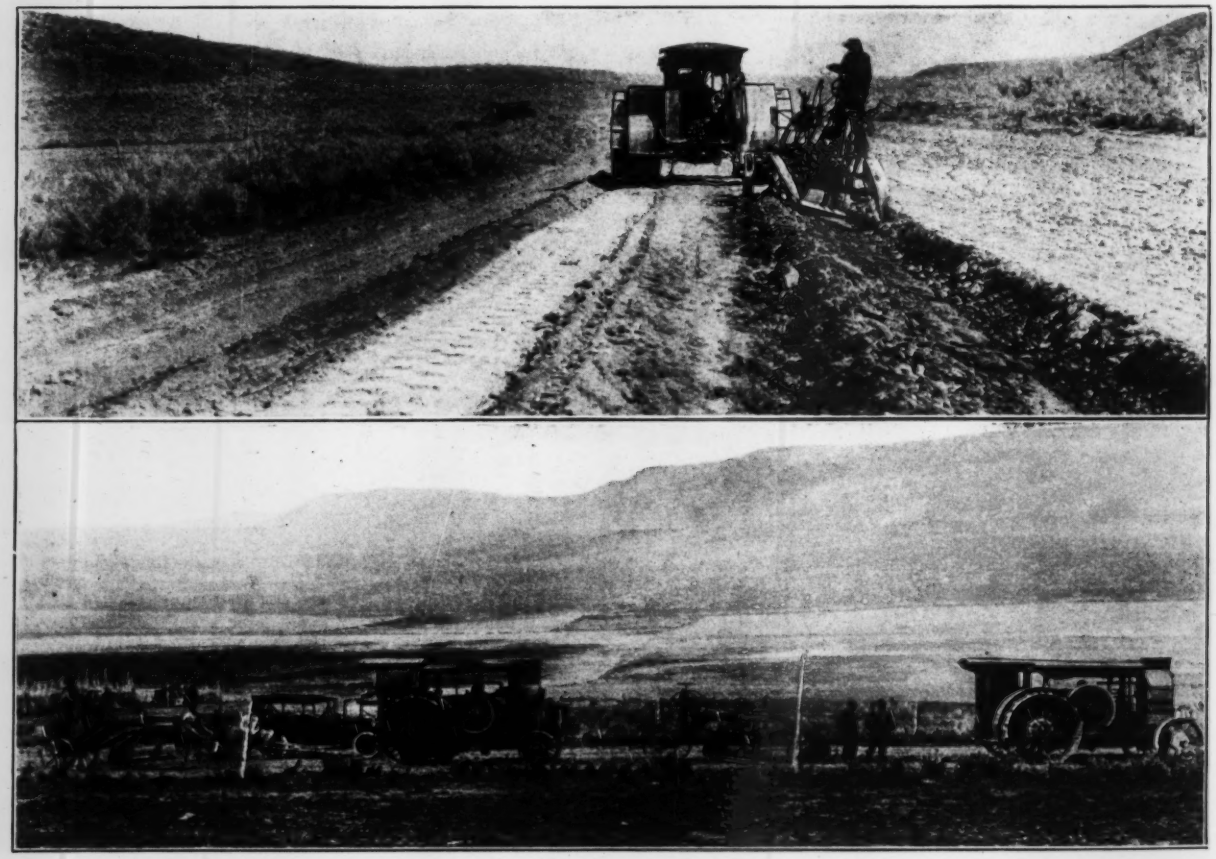


FIG. 2 (UPPER). MAKING FIRST CUT IN RIGHT-HAND DITCH. FIG. 3 (LOWER). GASOLINE TRACTOR-GRADER OUTFIT BUILDING MIDLAND TRAIL, BOX ELDER COUNTY, UTAH

along the line of the flags and is designed to give one-half the necessary depth to the ditch. At some convenient point the outfit is turned about and a similar cut made on the opposite side of the road. The second trip crowds the material excavated in the first trip to the crown of the road. The third cut excavates the ditch to grade and the fourth places this material on the crown.

Where ordinary sage brush is encountered the grader is first run over the roadbed with the blade set level a little above the surface. This cuts off the brush, after which a rooter and rake are used to clear the roadbed. Where the sage brush is extra heavy, a grubber has to be employed before the graders can be utilized.

The crew with the grading machines consists of only five men. Each unit requires a tractor operator and a grader operator, and there are a teamster and a four-horse team for hauling water, oil and supplies. It is sometimes convenient to grade over the culvert sites and place the culverts afterward by cutting the roadbed.

Where the state or county does not own the equipment the best results have been attained by leasing the tractor and grader operators and teams from a single contractor. This insures harmony and efficiency in operation. The two tractors and crews illustrated in Fig. 3 were leased for $7.50 per hr.

Similar work using teams and fresnos is done in some of the counties of the same state and the cost ranges from $300 to $600 per mi.

Six of the Utah counties are now using tractor-grader outfits similar to those illustrated. The tractors are proving so economical and efficient that it is planned to use them with wagon trains or trailers for placing the surfacing material. An experimental plant will be tried out this season, and it is hoped to reduce the cost of gravel-surfaced roads. The cost of graveling (6 to 8 in.) now runs from $500 to $1,500 a mi., depending on the proximity of the material.

The principal difficulties in operating the tractor-grader units have been in getting materials and supplies. So far as possible extra castings of all tractor parts liable to break are kept with the outfit.

The state highway department of Utah consists essentially of a State Road Commission of five members under which is the State Road Engineer and his staff. The state is divided into five groups of counties, and the general administration of the road work in each group is allotted to one of the commissioners, who is concerned chiefly with the financial problems. All road construction is under the State Road Engineer, although the State Engineer is a member of the commission. E. R. Morgan is the State Road Engineer.

Pile Formula Modified for Double-Acting Hammer

On a contract now under way the specification requires pile penetration for given loading to be determined by the well-known *Engineering News* pile formula. The contractor is using a double-acting steam pile-hammer, and the engineer inquires what form the formula ought to have under the conditions.

The *Engineering News* formula, devised by the late A. M. Wellington in 1888, is based on the equation between the energy stored in the hammer and the work done in overcoming the resistance to penetration. Two factors modify the equation—an allowance for dissipation of energy and a factor of safety. A factor of 6 is used. The dissipation of energy, by brooming, spring of the pile, etc., is supposed to be such as to reduce the penetrating effect by 1 in., in the case of a drop hammer, giving the formula

$$P = \frac{2Wh}{s + 1}$$

in which W = weight of hammer, pounds or tons; h = height of fall, feet; s = penetration, inches; P = pile capacity, pounds or tons.

For steam hammers the reduction is assumed to be only 0.1 in. (which represents less dissipation of energy on account of the decreased destructive effects of the hammer, due to the low fall and the more rapid blows), resulting in the formula

$$P = \frac{2Wh}{s + 0.1}$$

Recently several comparisons of steam-hammer driving with results derived from the formula have led various engineers to the conclusion that the steam-hammer loss of penetration is greater than 0.1 in. and should be taken at 0.3 in., giving the formula

$$P = \frac{2Wh}{s + 0.3}$$

The question now arises, What influence will the driving action of the steam exert? Its effect on brooming, rebound and similar dissipative actions is probably slight, and negligible in comparison with the conditions existing before the addition of the steam pressure. All factors of the formula are unchanged except the energy of the hammer, which is increased by the added velocity due to the steam action. At the same time a slightly increased penetration is secured. If the increased penetration is used in the formula without making allowance in the numerator for the increased energy of the hammer, the formula would appear to show lower load capacity in the case of piles driven by double-acting hammers than for piles driven with a free-falling steam hammer. This obviously would be incorrect. The following rule may be taken as a general guide:

Ascertain as nearly as possible the foot-pounds represented by the blow delivered by the hammer. This can be done by adding to the foot-pounds represented by the free fall of the hammer the foot-pounds obtained by multiplying the mean effective pressure by the area of the piston and the length of stroke in feet. The result is the numerator of the formula.

In the absence of specific data on mean effective pressure for the particular hammer assume that it amounts to 25 lb. per sq.in. Multiply this by the effective piston area and add the product to the weight of the hammer. This means using the formula in the shape,

$$P = \frac{(W + Ap)h}{s + 0.3}$$

in which, of course, P and W must be in pounds if the steam pressure is taken in pounds.

A Drilling Contest between a single-jacker and a jackhamer arranged by Louis A. Rehfuss, West Point, Calaveras County, Calif., resulted in the jackhamer, with air at 60 lb., drilling 81 in., while the hammersman drilled 9 in. The cost per jackhamer shift figured out 1.75 times that of the hand-drilling shift, but the cost per foot of hole drilled by the jackhamer figured only 19½% of the cost of hand-drilled hole.—"Engineering and Mining Journal," June 24.

Weak Retaining Wall Saved by Anchored Buttresses

A corner of one of the finest residences in Denver, Colo., was built over made ground, and the architect here erected a retaining wall that incloses both a corner of the house and an open veranda or children's play-yard backfilled to the level of the first floor, or some 6 or 7 ft. above the grading level.

Not much precaution was taken in placing foundations for this wall, and as a result it soon commenced to settle both downward and outward, opening large diagonal cracks, which were unsightly and threatened the safety of that corner of the house. The architect was at a loss for a remedy, so he "put it up to" a local contractor, C. S. Lambie, president of the C. S. Lambie Co.

The method adopted by Mr. Lambie was to drive sections of 8-in. cast-iron pipe along the footing of the wall and as close to it as possible. Fig. 2 shows a sketch. This pipe was driven to firm bearing in the original ground surface and partly filled with concrete. Then a 6-in. I-beam, bent to lie close to the wall, was inserted in each of the pipes and the pipes were filled with concrete to the top, making them essentially concrete piles.

Holes were drilled in the wall and the I-beams thoroughly tied into it by U-shaped rods. On the back face of the wall near its top a channel was placed and secured to the I-beams on the other side of the wall by two yokes, or U-shaped rods, at each pile, as shown in Fig. 2. From the ends of this short piece of channel, iron rods were inserted, the other ends of which were anchored to a block of concrete in the concrete pavement of the play-yard.

FIG. 1. STOPPING THE SETTLEMENT OF A DENVER RETAINING WALL

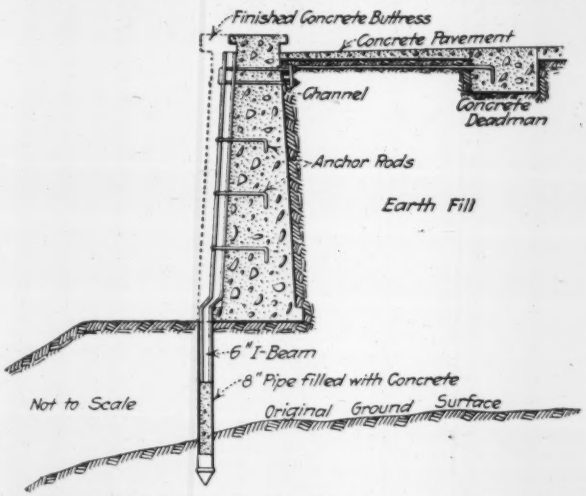


FIG. 2. CROSS-SECTION OF WALL AND REINFORCING BUTTRESS

The I-beams and ties were then inclosed in forms and filled around with concrete, giving the buttressed or pilastered wall shown in Fig. 1. When the whole had been finished to correspond to the rest of the residence, the architectural appearance had been improved rather than injured.

Manholes Built in Quicksand with Open Caisson

Building manholes by a modified open-caisson method was reported by the Underground Construction Committee of the National Electric Light Association at the recent Chicago convention, a member company having found the scheme advantageous.

The excavation to the quicksand is made in the ordinary manner. Then a wooden frame is built, having the same horizontal section as the manhole walls. This framework is built up of 2-in. planks to a total thickness of 6 in., the corners being well fastened so as to eliminate diagonal bracing and leave the center of the framework free for the excavation. The framework is then placed in a level position on the quicksand, and the manhole is built of brick to the required height, the walls being well plastered on the outside.

After setting for three or four days, the excavation of the manhole proceeds. By digging along the walls inside of the manhole and under the wooden framework the structure will usually settle to the required depth. During the excavation only sufficient water should be removed to allow the men to work to advantage, as otherwise the sand becomes quite hard. The settlement, if slow, can be accelerated by placing bags of sand or other weights on top of the manhole walls. Ordinarily the excavation and the settlement of the structure to the required depth will not require more than 8 or 10 hr. unless obstructions are encountered. After the manhole has reached the proper depth the settlement is stopped by backfilling the excava-

tion and tamping around the outside of the manhole walls.

Upon completion of the settlement the water is removed from the manhole, the sand excavated to the level of the bottom of the wooden framework, and a heavy concrete bottom is placed in the manhole. The openings for the conduit are cut in the manhole walls after it is entirely completed and settled to the proper depth.

In building such manholes the cost of labor is about double that of the ordinary manhole. The wooden framework is the only other item of expense.

Temporary Bascule Bridge for Construction Purposes

By H. Da Camara*

During the construction of the piers for the new Burlington Bridge across the Missouri River at Kansas City, Mo., it became necessary to find a method of carrying material over the channel without stopping navigation.

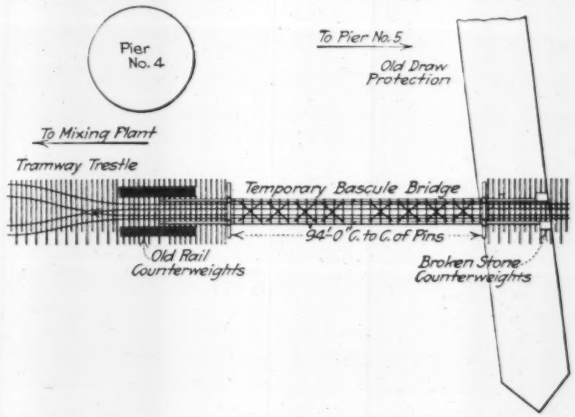


FIG. 1. GENERAL PLAN OF BASCULE BRIDGE SHOWING TRACK ARRANGEMENT

From the north shore out to Pier 4 a timber tramway, supported on pile bents spaced 15 ft. c. to c., had been used very successfully. This trestle was designed to carry a live load of 50 tons applied by a locomotive crane.

*4126 Virginia Ave., Kansas City, Mo.

The original plan was to continue the tramway on to Pier 5, cutting through the upstream end of the draw protection of the old Hannibal Bridge. Interference with some of the government boats was the immediate

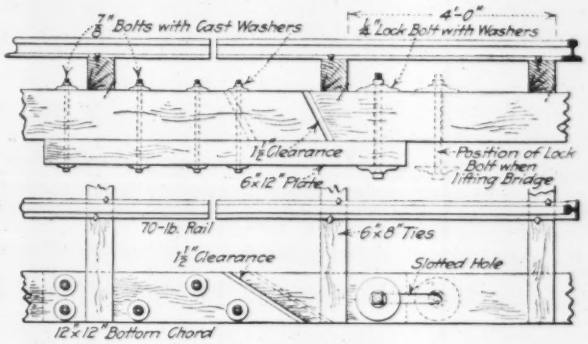


FIG. 4. DETAIL OF LEAF

cause of a change in this plan, although navigation was afterward (December) stopped by ice.

The engineers for the contractor decided to span the channel from the new Pier 4 to the old draw protection, a distance of about 100 ft., with a light wooden bascule bridge. The trunnion for the north half of the span was supported by a double bent of 12 cypress piles capped and braced as shown in Fig. 3. This bent came in line with the south side of the dock for Pier 4, so did not decrease the available channel width. The south half was carried entirely by the draw protection, except that one set of backstay cables was made fast to the cap of the first bent of the continued tram trestle. The towers were of 12x12-in. timbers fitted with ordinary timber-derrick mast shoes. The bracing consisted of 3x10s and 6x8s as shown in Fig. 1. The cable backstays were old 5/8-in. steel cable, four strands in the short sets and six strands in the long. The 12x12-in. stiff-legs served to make the whole more rigid.

The leaves of the bridge were constructed as shown in Fig. 4. Timber 47 ft. long carried the ties and rails. The lateral bracing was of 3x10s bolted to the under side of the 12x12s. The supporting cables were two strands of 5/8-in. steel wire fastened at each end by means of a

FIG. 2. SHOWING THE NEW BURLINGTON BRIDGE AT KANSAS CITY, AND THE TEMPORARY BASCULE BRIDGE CARRIED OUT BY ICE

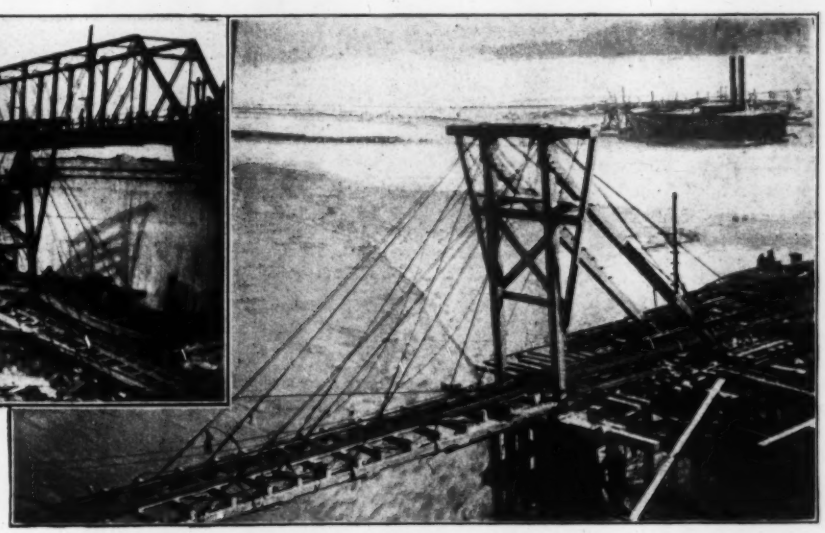


FIG. 3. NORTH LEAF

clevis to wire-cable lashings. The timbers were protected under these lashings by rail splice plates spiked on at the edges. Each of the supporting cables was made adjustable by the insertion of a turnbuckle or steamboat ratchet at the lower end.

The center connection, detailed in Fig. 4, was fitted with a lock bolt so arranged that the load of a car in passing was transmitted to both leaves of the bridge, making the deflection of the rail ends at this point the same. The bridge was designed to carry a live load of 5,000 lb. at the center of the span, produced by one yard of concrete, bucket and car. The concrete was transported by two cars running on parallel tracks. The cars were hauled by ½-in. cable from a two-drum hoisting engine, from the mixing plant to the derrick at the pier.

In order to continue this system to Pier 5 an ordinary rail frog was introduced at the north approach to the bridge as indicated in Fig. 1, thus in effect double-tracking the bridge. The passing point of the cars was 200 ft. north of the frog. In raising the leaves of the bridge, the lock bolts were moved as shown by the dotted position in Fig. 4. The north leaf could then be raised by the load line from either the derrick at Pier 4 or from the locomotive crane if it happened to be available. The south leaf was operated by a line run through snatch blocks from the third drum of the derrick engine to Pier 5.

The air pipes which were also carried by the bridge were fitted with rubber-hose expansion joints and united at the center of the span and at the hinges.

The bridge was used until the ice broke up and swept the north half, along with about 400 ft. of tramway, down the river (Fig. 2). As this did not damage the caisson for Pier 5 the remainder of the concrete was placed from a mixing plant on the south bank.

The Union Bridge and Construction Co. of Kansas City, Mo., was the contractor for the caisson work.

Half-Hour Performance of 4-Wheel Scrapers

Last season on a county-road contract in Summit County, Ohio, Windsor Brothers employed two sets of Maney 4-wheel scrapers, consisting of six machines each. Two hills, fairly close together, were cut through, the yardage amounting to 48,000 and the average haul to 500 ft. The deepest cut was over 20 ft. The soil was lay. Steep grades were encountered.

The performance of seven of these scrapers over a short period was watched by J. C. Gorman, Jr., District Manager of the Ransome Concrete Machinery Co., Columbus, and the following figures were compiled:

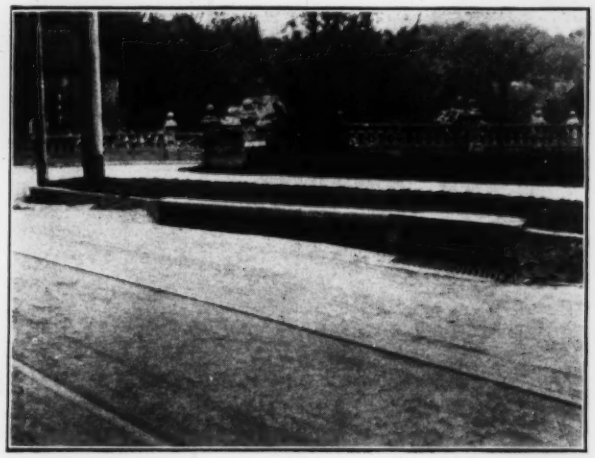
Length of haul	500 ft.
Time required to move 31 yd.	30 min.
7 scraper teams at 50c.	$3.50
Two 2-horse plow teams, each with drivers at 50c.	1.00
1 extra plowman	.20
1 snatch-hook man and horse	.30
2 dumpmen	.40
2 slopemen	.40
1 extra snatch-hook man	.20
1 engineer on hoist	.35
1 foreman	.50
1 hoistman	.50
Total	$7.35

At the rate of 31 yd. in 30 min., or 62 yd. per hr., the cost per yard moved is 12c. Unfortunately, data covering the entire job are not available.

The weight of a 1-yd. Maney scraper (2,200 lb.) makes tractor haulage almost a necessity. The Baker Manufacturing Co., which makes this scraper, also builds a ½-yd. 4-wheel scraper weighing 1,500 lb., which is more adapted to team haulage.

NOTES

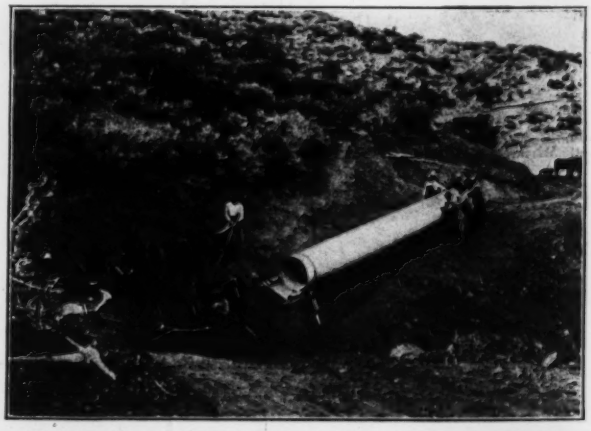
A Record Size Catchbasin Inlet is believed to be one 20 ft. long on a sidehill street in Council Bluffs, Iowa, shown in the accompanying illustration. The runoff demonstrated the need of such a large opening; the water comes in such volume and such rapidity as to flow by the original opening (to the right). The inlet is a series of compartments with a 24-in. outlet from each to a very large storm sewer under the street.



A 20-FT. CATCHBASIN INLET, COUNCIL BLUFFS, IOWA

It was installed several years ago by S. L. Etnyre, then city engineer, now superintendent of the water-works. Including the corner inlet, which is for all practical purposes part of the same sewer connection, the opening is 26 ft. from end to end.

Sledding Large Steel Culvert Pipe Cross-Country—Transporting large corrugated-steel pipe culverts over mountain trails ahead of the grading is often quite a problem. In one of the state highway divisions in northern Arizona, F. R. Goodman, division engineer, used the method of transportation shown by the view herewith, in which a 36-in. culvert 24 ft. long is being moved. The pipe is carried by two sleds made of scrap ends of 4x4's and shod with strap iron. The sleds are made high, to keep the pipe from rubbing against the ground, which would damage the zinc coating. As the view shows, a team of mules can take the culvert over fairly rough ground. Similar methods are used for transporting the flat corrugated plates used for headwalls.



SLEDDING A CORRUGATED STEEL CULVERT OVER THE ARIZONA HILLS

Editorials

Materials an Active Field

Useful information on the relative attracting power of an all-work and of a half-play convention is given by the attendance figures for the meetings of the American Society of Civil Engineers and the American Society for Testing Materials, both held last week. The facts appear to prove that engineers will go where their time will be put to the best practical use.

Formerly junket conventions were much the fashion, and most organizations believed that entertainment features were a vital element, however undesirable on general principles, of a convention. Such fashions and beliefs are getting to be obsolete, at least among engineers. Even the time-honored picnic style of the official railway conventions has in recent years been transformed. The great success of this year's Testing Materials meeting settles the matter conclusively.

Incidentally, there is no chance to doubt of the vitality of an organization that can draw a record-breaking increase of membership in the very year when it raises its dues by 50%. The American Society for Testing Materials has accomplished this, and now, with 2,071 members and a phenomenally broad and intense range of work, it stands strong among the most prominent technical organizations of the world.

While achieving this lofty position, the society has also stepped beyond the confines of earlier conservatism by electing as its president a manufacturer, or, as the society classes it, a producer—engineers in private practice being called nonproducers or consumers. The personality of the new executive, A. A. Stevenson of Philadelphia, makes it certain that the society will have no cause to repent of its iconoclasm. An efficient and energetic administration is needed more this year than at any time in the recent past. Expansion of work means new problems.

There are delicate problems in drawing specifications. A mortgage can not be more precise and binding in its terms than the right kind of specification for a technical material. The enthusiasm of the youthful investigator must be combined with the wise fairness of the grayheaded judge in writing the clauses. Many tendencies exist in drawing a new specification that run counter to this spirit of balance. There is often a natural desire, for example, to improve the state of the art by introducing cunning provisions which shall prevent the outside parties who will use the specification—seller and buyer—from entering into the particular kind of agreement that they wish and intend to make. Insofar as this may give rise to contradictions in the terms of the agreement actually made it is a harmful artifice. It makes the specification a poor legal document, one apt to create disputes and lawsuits rather than avoid them.

The work of a large subdivided body which creates specifications needs constant and careful supervision, in this regard and in others. To provide such supervision is a duty that becomes more urgent as well as more difficult as the work broadens out. There are present problems before the authorities of the American Society for Testing Materials, and more are likely to arise. But at the same time the situation justifies the hope that the problems will be successfully solved.

Broader Water-Works Vision

The trend of discussion on electrolysis and fire protection at the recent convention of the American Water-Works Association in New York City, noted in *Engineering News*, June 15, p. 1151, has raised questions in the minds of some as to the willingness of water-works men to coöperate with other utilities and agencies rendering public service. Do the water-works men need a broader vision?

Whatever their real intent may have been, a number of the water-works men at the convention gave the impression that they wished the Association to stand aloof from the present national coöperative study of the mitigation of electrolysis on underground structures.

It is a matter of great moment to the entire public if water and gas pipes or telephone and electric-supply cables are damaged by stray electric-railway currents so as to impair the quality or increase the cost of those utility services. It is of equally serious consequence if the absolute elimination of electrolysis is so costly that it would put the local transportation system out of business or dangerously increase the hazards of operation. In the face of such a situation the public interest demands that all the utilities in conflict coöperate in finding out precisely what the danger and damage are to the pipe and cable companies and what degree of minimization can be secured and supported by the transportation agency.

The courts have specifically laid that duty upon all the interests involved, on the one hand, just as they have recognized, on the other hand, the liability of the invading railway to meet the costs of such a suppression of stray currents as is practical, and to meet the damages to the prior occupant of the street.

This need of coöperation is a feature of utility regulation that all the existing commissions are bound to take up as they are given jurisdiction over water utilities. A few have such jurisdiction and have already begun to insist on coöperation.

A great advance has been made in the knowledge of electrolytic damage and in the practical suppression of stray railway currents since the national joint committee on electrolysis was formed to secure the coöperation of the water, gas, electric-light, telephone and street-railway interests. The water-works representatives were slow to join in the committee's deliberations and at the convention a few weeks ago strong opposition to representation on the joint committee was expressed, though no action against it was taken.

The argument is that the three water-works representatives sitting with six gas men, three telephone men,

three electric-light men, three steam railway men, three electric railway men, three professional electrical engineers and one United States Bureau of Standards representative will be outvoted—though the representatives of interests adversely affected by stray currents number 15, the railway men 6 and the neutrals 4. The water-works men urge that the other representatives have a community of private-corporation interests. The water-works men fear that the conclusions of a joint committee of such a character may be prejudicial to cities and to water companies engaged in hard fights to get compensation for electrolytic damages.

Alongside the electrolysis controversy, but differing from it in many respects, has been the wordy conflict between the water-works and the fire-insurance men over whether water supplied through private connections for the protection of factories should be paid for by the factory owner or by the city and whether such connections should be metered. There can be no charge of lack of coöperation in the consideration of this question heretofore, for the two leading water-works associations have yielded the floor for hours during one convention after another to insurance men. Each side has contended vigorously for what it has considered to be its own interests and for what it has also held to be the interest of the public. At the New York convention the water-works men, nettled somewhat by the fact that the discussion on this one subject was consuming practically all of "Superintendents' Day," finally withdrew the privilege of the floor from the insurance men.

The questions involved in the private fire service controversy include some far-reaching matters of public policy. It may be that they will never be settled until the public utility commissions are made legal arbitrators—which has seldom if ever been done as yet.

In both the electrolysis and private fire-service matters the water-works men are fighting for the integrity of their property and of the service which it is called upon to render. No one who has followed these controversies for a score or so of years can doubt the good intentions and the zeal of the water-works men. Like all who are fighting for principles and property, they might well cultivate greater breadth of vision and more of a spirit of toleration and coöperation.

Fortunately, when we come to measure the actual results at the recent meeting of the American Water-Works Association, it is seen that the acrimonious discussion did not wholly govern the resultant action. Committees will continue to work with other interests engaged in the study of electrolysis and fire protection.

Railway Car-Wheel Flanges and Frog Clearances

The late A. M. Wellington once remarked that it would be difficult to find anywhere in engineering a small amount of metal performing such an important service with such marvelous reliability as that rendered by the flange of a railway car wheel. This little projecting lip on the rim of a car wheel, only about an inch in thickness and in height when the wheel is new, is the sole means of protecting from derailment every wheel of every railway train in the world. As is well known, the great bulk of the car wheels in service in the United States are made of cast iron, and the engineer as a rule hesitates to trust cast iron where it is to be subjected to transverse stress and to shocks; but the casting of car wheels has been so perfected that their record of safety and reliability in service leaves little to be desired.

When Mr. Wellington made the remark quoted, the average railway freight car had a capacity of 30,000 to 40,000 lb. Freight cars of the present day are built to carry a load of 100,000 lb., and many of higher capacities are in service. In addition to this there has been a notable increase in freight-train speeds with a corresponding increase in shocks to the wheels and axles.

There has been a general feeling that because of the increase in stresses to which car wheels are subjected some additional thickness should be given to the wheel flange so that it might better withstand the severe and incomputable stresses which it receives.

As every engineer connected with railway work knows, however, the present standard practice as to width of openings through frogs, switches and guard rails is based upon the use of car wheels with flanges of the present standard thickness, and any material increase in the flange thickness would necessitate an alteration in these track standards. The difficulty of altering these standards is apparent. A railway freight car in its wanderings may run over the tracks of any railway in the United States and Canada. It is impossible, therefore, for any single railway company to change the thickness of its car-wheel flanges without endangering the operation of these cars on every railway that did not alter its track standards to correspond. Moreover, if a thicker wheel flange were adopted by the railways of the United States for new cars, there would be fully a dozen years while the car wheels already in service were wearing out during which there would be a variation in flange thicknesses. It would be unwise, of course, to begin the changing of track standards until at least a large majority of the cars in service had the thicker flanges, and during all this transition period there would be increased danger of derailments at switches and frogs.

Nevertheless, the Association of Manufacturers of Chilled Railway Car Wheels recommended some time ago that car-wheel flanges should be increased in thickness about ¼ in. As a result of this recommendation, the matter has been under investigation by committees of the Master Car Builders Association and the American Railway Engineering Association. At the recent meeting of the former association held at Atlantic City, its committee submitted a report in which it said that "nothing will be gained in the interest of safety or economy by adding metal to any portion of the flange of cast-iron car wheels in such locations as will in any way affect track clearances."

The investigation which led to this conclusion included a detailed study of car-wheel fractures and showed that the wheel fractures which caused derailments were almost invariably of a character that would not have been prevented by any increased thickness of the flange. Further than this, the committee reports that a certain railway had special wheels cast for use under its tenders having a flange ⅛ in. thicker than the standard. The average age of 203 of these wheels when condemned was 11 months, whereas of the same number of wheels with M. C. B. standard flanges in the same service the

average age when condemned was 11.1 months. Further, of these thick-flanged wheels condemned, 28% were thrown out of service on account of worn flanges, while of the wheels condemned having M. C. B. standard flanges but 15.2% were condemned on account of worn flanges. From this showing it would appear that the thickening of the wheel flange tends to increase the rate of flange wear. Two other railways reported to the committee that they had experimented with car wheels having thicker flanges and had found that the back of the flange in almost every case was grooved by contact with guard rails and frogs.

No better proof could be asked for that the present standard car-wheel flange is as thick as it can safely be made without a readjustment of track standards. The very great difficulty of maintaining safe operating conditions during the long transition period which would be necessary if a change in flange thickness were decided on has just been pointed out. It is exceedingly fortunate, therefore, that this small projection on the car wheel's rim, which seemed barely large enough for its work 25 years ago, is now proved to be still entirely reliable, notwithstanding the great increase in weights and speeds of rolling stock.

Once More One Accepted Cement Specification

The adoption last week by the annual meeting of the American Society for Testing Materials of the revised cement specification submitted by its committee on cement is a definite step forward toward that most desirable end—a nationally accepted cement standard. If, as seems probable, the last minute revisions are accepted by the government and by the civil engineers this specification will in fact, at least, warrant the name "American" quite rightly denied it in the title by the meeting.

Ten years ago the labeling of the universal acceptance of a cement specification as an important step forward would have sounded anachronistic, for following the promulgation of the 1904 standard specification the purchase of cement throughout the country was gradually being brought under the provisions of that standard. Individual or freaky specifications were growing rarer and rarer and hope was held out that in a year or two only a small percentage of the cement sold would have to answer other than the tests laid down by the American Society for Testing Materials.

But the knowledge of cement is in a state of flux. Old as are the fundamentals of this knowledge, the wonderful increase in the use of concrete has necessarily multiplied investigation and experience so that the facts of yesterday become the faults of today. Of all of the ingredients of concrete, cement suffered least in this increasing knowledge, but it did suffer somewhat and demands grew that the standards of purchase be changed to meet the new knowledge.

Unfortunately certain elements in the cement committee—elements made up not wholly though largely of the manufacturing interests—adopted an uncompromising Bourbonism. They resented change; they maintained through several years that not only had 50,000 or 60,000 or at last 100,000 copies of the old specification been distributed—of course an unanswerable argument for the specification—but that the standards set by that specification were the best conceivable for this or all time. With only minor retreats from this uncompromising position the cement committee stood for eight years until it was forced into a revisionary attitude by the promulgation of a separate government standard and the loss of the prestige not only of government sanction but of universal acceptance. The revision of last week is but tardy recognition of long standing constructive criticism.

The lessons of the past ten years should not be lost on the cement committee of the American Society for Testing Materials. Nothing could be further from the desirable than a constant annual shifting to meet the local winds of research and opinion, but a due respect for the developments of the art is incumbent. Science and engineering have no place for the precept "Whatever is, is right."

Boston Engineers Triumph

The order for reinstatement in city employ of three of the Boston engineers removed for political reasons last winter is a triumph for the cause of good government, the members of the engineering profession in Boston who aided in the fight for reinstatement and the engineers themselves.

Under the guise of the abolition of positions for the sake of efficiency and economy, 17 men in the Department of Works, mostly engineers, were summarily removed from office. Many had served Boston for years. The testimony in the lawsuit that has just terminated favorably indicated that the real causes of the removal were lack of political activity in favor of Mayor Curley, as shown by failure to attend political meetings and to contribute to party campaign funds. The attorney for the city objected naively to this line of testimony that there was nothing new in expecting political activity and soliciting campaign contributions. The testimony also appeared to show that appointments to offices new in title, the incumbents of which are to perform the same general duties as fell to those abolished, and increases in salaries added to instead of taking from the expenses of the Department.

It was also alleged that notwithstanding a charter provision requiring the appointing officer to certify that each appointee is qualified by training and experience for the duties of the position to be filled, at least one of the appointees to replace the politically decapitated men lacked experience in some of the new duties beyond having once run an instrument on that class of work. Some of these allegations may or may not be trivial in themselves, according to one's viewpoint, but taken together and with other factors, the Judge decided that the men had been removed or displaced in bad faith and ordered them reinstated.

In commenting on the wholesale decapitation last winter, we asked what the Boston engineers as a whole were going to do about it. They have answered nobly during the past few months by strongly backing the three employees who demanded reinstatement. This backing, we understand, included contributions to conduct the fight, as well as testimony in court—as noted elsewhere in this issue. The outcome does credit to the engineers of Boston and will be a help to the engineering profession and to better government throughout the whole country.

Letters to the Editor

Using Engineers in Present Military Emergency

Sir—I have been in receipt of numerous inquiries from engineers as to how their services could best be utilized in the present emergency along our southern border, and I have generally answered that the best service engineers can render at the present time is to join one of the engineer regiments of the National Guard, of which a large number must be raised to complete the engineer quota of the twelve infantry divisions of the National Guard.

I send this information to you thinking that it may be of interest to your readers. WILLIAM M. BLACK,
Chief of Engineers, U. S. Army.

Washington, D. C., June 30, 1916.

Railroad Valuation Surveys May Be Made Useful

Sir—The railroads of the United States are spending large amounts of money on the work of evaluating their physical plants in accordance with the La Follette Act, and judging from the comments in the engineering and economic press, the resulting figures and data will not be of great value to the railroads. I wish to draw attention to one way by which very useful and real benefits, which will be increasingly felt as the years go by, may be derived by the railroads from the re-surveys which are being made for use in the valuation work.

On any railroad of respectable age, how many detached surveys for special purposes have been made by the maintenance and other departments, each referred to some mile post, bridge backwall or other presumably permanent landmark? In a great many instances, especially as regards land and right-of-way information, new surveys are made when the notes of previous and much more valuable surveys are on file in the office, but cannot be used because they are referred to a mile post which has been destroyed and carelessly replaced by the road forces at a different place, or to the former position of the backwall of a bridge which has since been partly filled in. How useful would all those old surveys be in the present valuation if they were referred to some common datum of levels and alignment?

The present valuation surveys would serve admirably as a reference basis for future surveys and could be made available for that purpose at small expense. Two permanent monuments set at random on the company's property out of the way of future improvements and possibly 20 to 30 ft. from the track, would give a line to which two stations of the track survey might be referred. These pairs of monuments might be placed at intervals of about a mile or less, and would be used as the initial or closing point of all future surveys.

A piece of scrap rail 4 ft. long, pointed at the forge and driven with a sledge until nearly flush with the surface of the ground and marked on the top with a center punch would make a good and permanent monument. Situation sketches giving the elevation and notes needed to find the monuments would be necessary and these should be made on transparent sheets of standard field-book size so that they could be blueprinted and thus made conveniently available for use by the field parties. It is, of course, also necessary that some proper system of indexing and filing the field notes be used.

Unless this or some more suitable method of rendering the present surveys permanently available as a common basis for future surveys is soon taken, the opportunity will have passed and the expense of obtaining equally good results as those now available will be greatly increased. WALTER H. DUNLAP.

Washington, D. C., June 21, 1916.

[It may be possible that some of the railways are doing the very thing suggested by the writer, and if so it would be worth while for the facts to go on record. *Engineering News* will be pleased to make note of such instances.—Editor.]

Government and Student Free Engineering Service

Sir—The editorial in your issue of June 1 entitled "Government and Student Free Engineering Service," leads the writer to present a phase of the subject that has not, so far as he knows, been discussed. Putting aside the question of relative quality of the work turned out by senior students under the guidance of their professor and which is donated to the individual client at the expense of the taxpayers of the state—a most unequal distribution of burden—there is yet to be considered a more vicious result where the practice extends over a term of years.

Consider this. The senior class that today furnishes free engineering service will become the practicing engineers in ten years time and will in turn be subjected to the competition of the then existing senior class and its free engineering service. This competition cuts down the earnings of the practicing engineer and consequently lessens the value of his investment and the state's investment in his education, and it may readily become severe enough to cause him to abandon his engineering activities entirely and seek other means of livelihood. One of the purposes of the institution being to train young men in the fundamentals of engineering science so that there will grow up in the state a body of efficient men skilled in developing the various resources of the state, and thereby react in many ways to the advantage of the general public, any act or system that reduces or destroys the effectiveness of that body defeats to the same extent the purpose of the institution and prevents it from fully justifying its existence. There is nothing gained by training young men in engineering science if later on in life they must abandon their chosen field because the

institution which nourished them takes away their means of livelihood. The practice of tearing down with one hand while trying to build up with the other is puerile and can produce nothing lasting nor worth while.

The engineering student has about one year to be a senior and perhaps 35 to 40 years to be a practicing engineer. Why establish a system of free service that may be of some slight benefit to the senior student for one scholastic year and then be a constant menace and a greater detriment to him during the subsequent period of his professional life? The effectiveness of the practicing engineer is reduced and his influence curtailed in proportion to the reduction in his income; for he cannot employ as many of the younger graduates, he cannot so well serve as a man of affairs in his community, he cannot so effectively influence investors to back legitimate projects for the development of the state, nor can he so materially increase the standing of the engineering profession with the public. The net result of the free-service system extending over a term of years is to reduce the income of the practicing engineer, to cause him to abandon his profession, to reduce his effectiveness as a citizen and a man of affairs, to nullify the purpose of the institution, and to waste the taxpayers' money in an educational investment that does not bring the returns that it should. ROBERT C. BARNETT.

Kansas City, Mo., June 12, 1916.

Sir—The attention of the United States Public Health Service has been called to the editorial appearing in your issue of June 1, 1916, and especially to the paragraph reading as follows:

> A far more serious question than the effect on the profession is the character of the service likely to be rendered under conditions of either Federal aid or free assistance by engineering students. In saying this, we are not questioning the advice given by the United States Public Health Service in the particular case in hand. As a general proposition, however, the various branches of the Federal government are not sufficiently well manned either in numbers or professional competence of the majority of such staff as exists to make proper studies of local questions, determine all the various facts based upon local conditions, and then give advice—much less prepare plans and specifications—that will meet the needs of the case.

As the editorial refers to engineering service, and as the Public Health Service is the only branch of the Federal government mentioned in the previous discussion or likely to be called upon for advice of the kind mentioned, this reference must be construed as a criticism of the professional competency of the Public Health Service to give advice in matters involving engineering projects.

In view of the varied activities of the Public Health Service it would seem neither necessary nor desirable that a majority, or any considerable proportion, of its corps be particularly skilled in the relatively small phase of the Service work requiring a technical knowledge of sanitary engineering or familiarity with its principles. The comparatively small number of the local investigations undertaken requiring such knowledge are invariably assigned to members of the corps especially fitted by education and training for such work; and these officers are always allowed sufficient time and facilities to investigate the facts thoroughly. Such local investigations have to do almost always with questions of the efficiency of engineering structures such as water-purification or sewage-disposal plants, or with the necessity for new structures. The advice given refers only to the general principles to be followed, not with the design of structures, always recommending that the advice of competent engineers be followed in the selection of detailed plans. Conclusions and advice having to do with such questions are invariably reviewed by engineers of the Service of high standing and ample experience.

The character of the work done by this portion of the Public Health Service corps in their broader investigations constitutes a sufficient answer to the implication that such men are not professionally competent to render advice on the principles to be followed in solving local public health problems. A review of reports rendered by the Public Health Service on local conditions will show, moreover, that the conclusions reached are based ordinarily either upon thorough investigations by the Service or upon the consideration of sufficiently reliable data previously collected by competent engineers.

It is therefore apparent that the editorial in your journal has been based on a misconception of the work undertaken by this Service and the qualifications of its engineering staff. A. H. GLENNAN,

Acting Surgeon-General.

Public Health Service, Washington, D. C.,
June 10, 1916.

[As to the second of the two foregoing letters, the paragraph quoted in it from our editorial of June 1, was carefully phrased (1) to disclaim criticism of the advice given by the Public Health Service in the Lexington sewage-treatment case, and (2) to include "the various branches of the Federal government" that from time to time render engineering assistance on local as distinct from Federal questions.—Editor.]

Notepaper Defended

Gentlemen:—

In the June 8th *Engineering News* is an article "The Applicant's Difficulty" by R. Fleming.

Finding fault with an application, because it is written on notepaper, is silly.

What difference does the paper make? What it reads would interest most people.

I use notepaper in my personal business, exclusively, and so do many others.

There never will be a standard letter sheet. Too many people and firms have a liking for "the different."

In my office I receive letters in all, sizes, shades, and odd printing. Everyone gets personal attention and there is no trouble in filing them.

I wonder, if he ever tried to buy business paper on a Sunday or in the evening. If he did, he tried at the local drug store, and its dollars to doughnuts that what he got was notepaper.

I'd consider a letter, carefully, if it was written on a tomatoe can cover. What's in it is what interests me.

Yours very truly,

. . . . . .

[We print the above letter exactly as it was written, omitting the signature. Any comment upon it would be superfluous.—Editor.]

Activated-Sludge Experiments on London Sewage are being conducted by the County Council of London, England, according to the latest annual report of the council. During the year reviewed by the report more than 20,000 long tons of lime and 5,000 long tons of protosulphate of iron were used at the two chemical precipitation plants maintained by the council.

Important Committee Work in Materials Testing Society

SYNOPSIS—Report of annual meeting of American Society for Testing Materials, Atlantic City, N. J., June 27-30, 1916.

Replacing the existing standard specification for portland cement by a radically new one, revising nearly all the steel specifications except those for rails, and establishing a dozen or two other new specifications were the technical achievements of the annual meeting of the American Society for Testing Materials, held last week in the customary congeniality of Atlantic City, N. J. Apart from this, however, the meeting had a new and distinct tone due to the strong growth of committee activities. One or two knotty problems springing out of this growth presented themselves, and they are likely to keep the society's officers busy during the coming year.

There was a slump in the number and range of technical papers, for which the large amount of committee work is at least partly responsible. However, some papers of first importance were read. The cracking disease of brass and bronze was partly cleared up, new light was thrown on heat-treatment changes in high-carbon steel, endurance testing and the elastic-limit problem were usefully discussed, etc.

That the society has outstripped some of the older and larger engineering organizations in point of technical importance was demonstrated pretty well by the attendance at the meeting. It happened that the American Society of Civil Engineers held its summer convention at the same time, in Pittsburgh, but many of its members cut the convention in favor of the Atlantic City meeting. The latter broke its own record of attendance, in spite of the counter-attraction. No less than 513 men were registered, against 489 last year, and even by Wednesday evening, June 28, when the Pittsburgh convention was in full blast, the attendance had reached 455.

A. S. T. M. Specifications Will Stimulate South American Trade

Two unusual events emphasized the importance of the specifying and standardizing work to which the society is chiefly devoted. An agreement was reached between the Department of Commerce and Labor of the U. S. Government and the society's executive committee under which the department will translate the A. S. T. M. specifications into Spanish and will circulate them free through the South American consular offices. Already over 30 of them have been translated.

Alongside this government recognition stands an equally significant recognition by the architectural profession, which has hitherto held aloof from the testing engineers. The American Institute of Architects was represented by Prof. Thomas Nolan (University of Pennsylvania), who made the following statement to the meeting:

> The American Institute of Architects has just appointed a new Standing Committee on Materials and Methods, to collect, record and publish for the architectural profession, in a more efficient manner than heretofore, the most important results of investigations of the materials and methods of construction, carried on by the American Society for Testing Materials, the engineering societies and similar organizations.

The address of the president, Mansfield Merriman, under the title "The Work of Committees," happened to touch on some of the very conditions that featured the meeting. Describing the origin of the society's system of working out results by standing technical committees, Mr. Merriman defined the principles on which the success of the system depends. Among them he included the coöperation of the society at large in the final stage of the work by its letter ballot on the adoption of standards—a proceeding subjected to considerable criticism in recent years.

About one-third of the entire membership is engaged in the committee work, yet its cost to the society is only $1,200 per year for 37 committees. Mr. Merriman suggested that larger expenditures in this direction are in order, now that the society is no longer hampered by annual deficits. Increase of the membership dues on Jan. 1, 1916, is producing an additional income which will in the first year wipe out the accumulated deficits.

Specifying Engineering Design and Methods

The society is confronted by serious unsolved problems in the desire of certain committees to prescribe not only the material but also how that material may be used. Thus, one committee in specifying the qualities of gypsum plasters wished to limit the framing of the building to a minimum spacing of 16 in., and proceeded still farther to tell what lath must be used and how they must be nailed on, not to speak of detailed rules for applying the scratch coat, the brown coat and the finishing coat. Fortunately the committee reconsidered, and withdrew the whole proposed specification before actually coming into the meeting.

The difficulty was brought on two years ago by the Drain-Tile Committee (chairman, Prof. A. Marston, Ames, Iowa), followed by the Sewer-Pipe Committee (chairman, Rudolph Hering, New York). The former insisted that the quality of drain tile cannot be specified successfully unless the pressure of earth on pipe in trenches and the right way to lay the pipe be specified at the same time. It drew up a specification covering all three matters, and this specification was adopted by the society in 1914. The Sewer-Pipe Committee, followed suit with a document entitled "Recommended Practice in Laying Sewer Pipe," which in 1915 was accepted by the society as tentative, though not accompanied by a specification for quality of sewer pipe.

Thereupon the Executive Committee, believing that the society should stick to its own work on quality of materials and keep clear of the engineering questions involved in the use of materials, established the principle that in general the committees should not include matters of engineering design or construction in their specifications, but that they might do so if necessary. This declaration has had but little effect up to the present, and the question involved appears to be still unsettled.

The Drain-Tile Committee this year reported a radically new specification, restricted mainly to specifying quality of tile, but retaining some essential reference to

earth pressure or to methods of laying. The Sewer-Pipe Committee adhered to its intention to specify recommended practice in laying pipe sewers, and indeed revised the specification. The Gypsum Committee, already mentioned, made the widest divergence from the principle declared, but by later withdrawing its specification kept the question from coming up for direct discussion.

The Society Resumes Control of Committees

Action was taken in two or three matters to place restraint on the tendency of committees to assume absolute control of their fields. This tendency, appearing with the growth in weight of the committees and their work, had the result that in recent years proposed specifications went through the society meetings in routine fashion, and lively discussion was rare. This year several committees undertook to put their specifications through without a one-year trial as provided by the rules. But if any expectations were based on the tame attitude of prior meetings they experienced a partial disappointment. A fight developed when the Road Materials Committee made its proposal for immediate adoption without revealing adequate reasons for the request, and the committee was overruled as to an entire group of specifications.

Another squabble, this time on definitions of special technical terms, led to preliminary steps toward appointment of a Nomenclature Committee. Definitions have up to now been prepared by the technical committees for their several subjects, and frequent overlap developed, with controversy over who had jurisdiction. When the Gypsum Committee presented definitions including one for concrete, and it appeared that a rather novel and academic meaning was to be formally tacked on to this well-fixed term, objection was raised, and in consequence the committee received a mild rebuke: It was instructed next year to justify its endeavors to deal with terms that apparently are not in the immediate field of the committee.

The Cement Committee took the very large view that its new cement specification will monopolize the field so thoroughly that it should be called "American Standard Specification," and that this name should be given it by the American Society for Testing Materials. The tone of the society meeting was more modest, and the committee's proposal was turned down gracefully. The title "A. S. T. M. Standard Specification" was considered good enough.

An unusual decision affecting the clearness of specifications was reached by the Executive Committee during the past year. The question was raised at last year's meeting whether it would not be best to prohibit discrimination between two or more materials unless the same specification contained a method of distinguishing the materials. By the decision now reached it is "inexpedient to approve this proposal because in some cases there are no known methods of distinguishing different materials without direct knowledge of their origin." The case of acid and basic openhearth steel has been cited in support of this decision.

Micrography and Structure Studies in the Foreground

In the independent papers, and to some extent in committee reports, micrographic and other study of internal structure was very much to the fore. This is true not only as to amount of use of structure study, but also as to definiteness and convincing character of the proof furnished. A leading case in the latter regard was a paper on improving brass condenser tubes, by A. E. White, in which the entire argument on limits of annealing temperature was set forth and proven in remarkably clear manner by a series of accurately comparable micro-sections.

The importance of microstructure studies stood out so much, in fact, that when the suggestion was made that magnifications ought to be standardized there was prompt general approval of the idea, and committee work on the subject will doubtless be initiated shortly.

Coöperation with Other Organizations

Notable among coöperative efforts was the work of the Joint Committee on Concrete and Reinforced Concrete, and this, unfortunately, seems to have reached a point where either the committee or its coöperation or both are in a bad way. Similarly in the co-called Joint Conference on the cement specification the coöperation partly failed, inasmuch as the agreement reached in conference was upset when the society's Cement Committee met by itself. In general, however, the extent of co-operation is growing steadily, and even the failures are such only in superficial appearance. The two new cases of coöperation—real or prospective—with the Department of Commerce and with the architects, represent a weighty addition to the prior list.

Remaking the Portland Cement Specification

After four years of labor, the committee on Cement presented a revision of the requirements for portland cement in the present Standard Specifications for Cement, adopted in 1904 and slightly revised in 1908 and 1909. This latest revision consists in an entire rewriting of the specifications, a number of changes in the requirements, and the incorporation in the specifications of the method of making the tests, which has hitherto been an appendix of the specifications in the form of the recommendations of a special committee of the American Society of Civil Engineers. The requirements for natural cement have not as yet been revised, although the new methods of making tests will apply to natural as well as portland cement (see page 43 of this issue).

It may be worth while here to set down briefly a history of the specification.

The first standard specification for cement was adopted by the American Society for Testing Materials in 1904 and soon received extended recognition as a laudable attempt to standardize what had up to that time been variable practice. In a few years, however, the constantly changing views on concrete and on cement led to a number of complaints mainly by engineers, as to the requirements of the specifications and repeated efforts were made to get the committee to revise the standards. A certain conservatism, inspired by a desire for a reasonable permanence in standards even at the expense of minor error, managed to prevent any changes in the specifications until 1908 (and again 1909) when some changes, mostly in the tensile requirements, were made.

In 1912, however, the Federal departments by executive order were compelled to adopt for use in all of their work a government specification for cement which had been prepared by a special committee of government en-

gineers. This was a severe blow to the prestige of the A. S. T. M. Standard specifications. So in March, 1912, the society's cement committee recommended that a conference committee of the American Society of Civil Engineers, the Government Departmental Committee and the American Society for Testing Materials be organized "to confer for the purpose of reconciling differences" in the specifications. In pursuance of this recommendation on Oct. 24, 1912, the Joint Conference on Uniform Methods of Test and Standard Specifications for Cement was organized.

This conference reached practical agreement on Apr. 28, 1915, but its report, an extensive volume, was considered by the Cement Committee to be more elaborate than its instructions permitted and the recommendations contained therein were not made public but were, at the annual meeting of 1915, made the subject of consideration of subcommittees for the ensuing year. During the past year the Conference and the Committee agreed on a specification which was sent out for information some months ago and which, as revised by the Committee (the Conference not being present) in meeting at Atlantic City on June 28, 1916, was submitted to the meeting of the society on June 29.

The specification was subjected to little criticism on the floor, but about an hour was used up in a spirited discussion on the title for the specification submitted by the Committee. To quote the report:

> The committee recommends that the proposed revised specifications for portland cement be given the title "American Specifications and Methods of Tests for Portland Cement." In the judgment of the committee, they are entitled to this distinction because they are the result of several years' work of the special committees representing the Board of Direction of the American Society of Civil Engineers, the United States Government Departmental Committee, and Committee C-1. It is highly desirable to convey not only to those who use cement in this country, but also to our export trade, that there is a single uniform American specification for this important product.

This recommendation was referred to the Board of Direction, which returned it for the consideration of the meeting, with the statement that in the Board's opinion such action would be insidious since there are numerous other specifications of the society to which the same arguments as to title apply. The discussion resolved itself into two sides one of which argued for the "American" in the title because of the impressive effect on South American trade and as a recognition of the three interests involved in the producing of the specifications. The opposition upheld the Board of Direction and further disputed the right of any body to usurp the word "American." The opposition won out and the title has been referred to the Board of Direction.

Finally it should be said that up to now neither the American Society of Civil Engineers nor the Government Committee has accepted the specifications as revised on June 28, so that those specifications so far are only the tentative Standards of the American Society for Testing Materials, to become effective as such Jan. 1, 1917, subject to the approval of the letter ballot of the society.

The Cement Committee further submitted proposed tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar, which may later be made a part of the Cement Specifications. The compression test recommended is on 2x4-in. cylinders instead of on the 2x2-in. cubes which have been mentioned in previous compression recommendations, and for that reason was objected to on the floor. The specification, however, was adopted as tentative.

The personnel of the committee is to be changed. George F. Swain, chairman, George S. Webster, vice-chairman and Richard L. Humphrey, secretary, have resigned and their places are to be filled by Russell S. Greenman, of the State Engineer's office of New York, as chairman, H. B. MacFarland, Testing Engineer of the Atchison, Topeka & Santa Fe Ry., vice-chairman, and P. H. Bates, of the United States Bureau of Standards, secretary.

New Metal Specifications

The Steel Committee recommended changes in a large number of its specifications, showing that its activity during the year was well up to normal. Most of the changes are of minor character, for example, the whole group of structural steel specifications is revised only by change of the table of permissible variation of plates to accord better with experience.

Boiler and firebox steel is affected by making the bend test much less severe, the specimen however to be taken from the top of the plate to give a check on the uniformity of the metal. The old specification, with this change, was retained for locomotive use, over the objections of C. L. Huston, who questioned the new bend-test clauses. A wholly new specification was drafted for stationary boilers, in order to get into closest possible agreement with the Boiler Code of the American Society of Mechanical Engineers. It differs from the Boiler Code in respect to the bend test and also in allowing a slightly greater range of tensile strength.

A noteworthy little innovation was made in the standard 2-in. tension test specimen, which for years has had ½-in. diameter and threaded ends to screw into the grips. Shouldered ends, for use with socket grips, were made permissive, to agree with the adoption of socket grips in some leading laboratories during the year. In regard to diameter the committee showed remarkable agility of mind. In its preprinted report it recommended changing from ½-in. to 0.505 in., which would give a cross-section of ⅕ sq.in. Before coming into the meeting, however, it changed its mind back to ½ in., and the meeting accepted the recommendation without asking an explanation.

New specifications drafted by this committee cover track spikes, screw spikes, tie plates, spring bars with special silicon requirements, and automobile springs, besides boiler steel as noted above.

Several laboratory researches were carried out for the committee. One of them, by J. R. Cain and H. S. Rawdon, of the Bureau of Standards, aimed to determine how reliable is the ladle test of steel. Ladle-test ingots were found to be segregated and unsound, and various analyses of them differed accordingly. Further work is planned to develop a method of getting good ladle-test ingots.

All the revisions and new specifications proposed by the committee were accepted by the society in the form proposed (standard or tentative).

The Wrought Iron Committee on the contrary was practically inactive. A corrected table of minimum weights was inserted in the boiler-tube specification, however.

The committee on Nonferrous Metals took up during the year the subject of copper and brass for fire-

box and tube service. Four specifications were formulated as a result, and all of them were accepted by the meeting as tentative: Copper Plates for Locomotive Fireboxes, Copper Bars for Locomotive Staybolts, Seamless Copper Boiler Tubes, and Seamless Brass Boiler Tubes. Other work by this committee was extensive revision of the specification for spelter, and a new specification for railway bearing alloys, but the latter was referred back to the committee after criticism.

Copper wire is in the hands of another committee. Two specifications were approved as standard, after being tentative for the past year and then being revised slightly: For bare concentric-lay copper cable, and for high-strength bronze trolley wire. A specification for insulated wire was approved as tentative.

Other New Specifications

Paint materials are affected by a revised specification for purity of raw tung oil (the new name for Chinese wood oil), tests for shellac, tests for distillation of paint thinners other than turpentine, and methods for routine analysis of white pigments. The three latter are tentative only.

In fuels, specifications for coke and for sampling and analysis of coal were (after revision) advanced to the rank of standards, having been proposed as tentative last year. Methods for laboratory sampling and analysis of coke were accepted as tentative.

Road materials gave rise to a sharp controversy between the committee and the meeting, which resulted in accepting many of the specifications as tentative only, while the committee wished nine-tenths consent to advance them at once to the rank of standards. The new specifications are for certain grades of broken stone, determining specific gravity of homogeneous coarse aggregates, mechanical analysis of aggregates (concrete aggregates excepted), penetration test of bituminous materials, test for loss on heating of oil and asphaltic compounds, method of distillation of bituminous materials suitable for road treatment, and determination of softening point of bituminous materials other than tar products.

The density grading recently applied to Southern yellow pine has been extended to Douglas fir, under substantially the same wording. The Timber Committee reported a specification for bridge and trestle timbers of this wood, under which only the "dense" grade is acceptable. This was adopted as tentative. A revised specification for sampling and analysis of creosote oil was also accepted as tentative.

A tentative specification for fire hose for public department use, reported by the Rubber Products Committee, was accepted. The same was done with a group of specifications for cotton fabrics for automobile tires and for hose and belting, wherein different tests are established for the two classes of fabric. Commercial considerations appear to have controlled in formulating the latter specifications. There was an interesting set of five papers reporting results on comparative tests of the two test methods specified, which established the superiority of one method.

A curious situation arose as to elastic limit in tension testing. The society's standard methods of mechanical testing were slightly supplemented and revised, chiefly as regards "elastic limit," now defined as beginning of set. Coincident with this change, however, the Steel Committee put into use a very different definition. An improvement was introduced in specifications for steel forgings providing for a new way of determining the elastic limit, but without any reference to permanent set: An extensometer reading to 0.0002 in. shall be used, and while the load on the specimen is increased at a uniform rate the observer shall watch for the point at which the rate of elongation shows a sudden increase, this point to be recorded as the elastic limit.

The ancient question of what is elastic limit, involved in the above, was illuminated by an excellent topical discussion joined in by J. E. Howard, T. D. Lynch, H. F. Moore and F. B. Seeley. This discussion tended to establish the view that proportional limit and set limit are identical.

The standard tests for magnetic properties of iron and steel were revised extensively by detailing tests suitable for permanent magnets.

Notes of Progress

Interesting progress is being made in some phases of the committee work not represented in the above. On the subject of shipping containers, a test apparatus of the foundry-rattler type for boxes, etc., is being shaped up to serviceable form. On concrete aggregates work is being done that may lead to some definite knowledge of what to put into concrete mixtures. The most vital work seems to be an elaborate study of impurities in sands, being carried on by D. A. Abrams and O. E. Harder at Lewis Institute, Chicago.

The Sewer-Pipe Committee has formulated a full and valuable discussion of the service of sewer pipes and means of coördinating quality with service. Every engineer concerned even remotely with sewers ought to read this monograph.

The Paint Committee has started tests on the efficiency of different methods of cleaning the surface of steel before painting—a subject on which practically no knowledge exists. Similarly the Corrosion Committee, now also in charge of metallic coatings, is starting two important comparative tests, one on relative corrosion of 100 or more sheets of different irons, the other on galvanizing.

The Rubber Products Committee is working successfully on specifications for rubber insulating tape, the Copper Wire Committee on tinned copper wire. The Gypsum Committee has already made great progress in its work on gypsum and plasters and methods of test for them, and is likely to bring this work to full success in the next year.

In numerous other subjects, as heat treatment, waterproofing, and cast-iron soil pipe, little or no progress can be recorded.

New Officers and Regulations

A. A. Stevenson, of the Standard Steel Works, Philadelphia, Penn., was elected president for the coming year, and S. S. Voorhees, of the Bureau of Standards, Washington, D. C., vice-president. The new members of the executive committee are W. H. Bassett, John Brunner, G. W. Thompson and F. E. Turneaure.

A change was made in the manner of selecting the nominating committee (now chosen by referendum), by making elected members of the committee ineligible for service the following year. A new regulation allowing proxy voting in the technical committees was adopted.

New Chief Engineer of the Baltimore & Ohio

Francis Lee Stuart has resigned as chief engineer of the Baltimore & Ohio R.R., effective July 10, to engage in private practice with offices in New York City. He will be succeeded as chief engineer of the Baltimore & Ohio by Ralph Norman Begien, now General Superintendent of the Baltimore & Ohio Southwestern at Cincinnati.

Mr. Stuart has been chief engineer since Jan. 1, 1911, previous to which he was for five years chief engineer of the Erie R.R. Under his direction a very extensive program of improvements has been carried out on the Baltimore & Ohio, including the construction of three- and four-track lines in mountainous country, grade reductions and curve eliminations, etc. The Magnolia cutoff, on the eastern end of the Cumberland division in West Virginia, described in *Engineering News*, June 29, is among the many important projects carried through by Mr. Stuart. The double-track tunnels on the main line through the Allegheny Mountains at Sand Patch, Penn., and Kingwood, W. Va., are other notable engineering achievements during this period.

R. N. Begien, the new chief engineer of the Baltimore & Ohio system is a native of Boston and an engineering graduate of Harvard University, class of 1897. For three years he was engaged in survey work in Central America for the Nicaraguan Canal Commission, after which he spent a year in railway work in Ecuador. Returning to this country he was for a short time with the Engineering Department of the District of Columbia at Washington. In 1902 he joined the engineering staff of the Baltimore & Ohio R.R. as an assistant engineer on surveys and construction of trunk line and branch line improvements, and later was on special work under the chief engineer at Baltimore. From 1908 to 1909 he was division engineer at Philadelphia, then acting engineer of maintenance-of-way of the main line system, assistant to chief engineer, assistant to general manager, assistant to third vice-president, assistant general superintendent and recently general superintendent of the B. & O. Southwestern.

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Water for a Million People Proposed at Seattle

A water-supply program to provide ultimately for a population of 1,000,000 at a cost of $8,182,000 was outlined in a report to the city council of Seattle, Wash., made on June 15 by A. J. Dimock, City Engineer, and L. B. Youngs, Superintendent of Water. The Cedar River source of supply would be retained, but the present wood-stave conduits would be supplemented and eventually displaced by a concrete aqueduct to a point below Swan Lake and by two steel conduits below that point. Swan Lake, well down the conduit line toward the city, would be converted into a large storage reservoir and the storage within the city would be materially increased. The distributing system would be reinforced by trunk lines. This work would be carried out in sections, according to need rather than natural order. The scheme provides for an ultimate capacity of 150,000,000 gal. a day, which at 150 gal. per capita would serve 1,000,000 people, or the population in 1950 suggested by the Seattle expectancy curve.

The present supply is conveyed to Seattle through two wood-stave pipe lines, completed in 1901 and in 1909. No. 1 is 28 mi. long, and has diameters as follows: 54 in. to screening chamber, ½ mi.; 44 in. to a point 1 mi. west of Swan Lake, 10 mi.; 42 in. to Volunteer Park reservoir, 17½ mi. At three stream crossings, the 42-in. wood pipe gives way to steel. No. 2 is 34¼ mi. long, parallel with No. 1 as far as Volunteer Park, and only 10 ft. from it most of that distance. The diameters of No. 1 are: 54 in. to the screen chamber ½ mi.: 60 in. for 10 mi., to a point near Swan Lake; 51½ in. for 14 mi. to Beacon Hill reservoir; 48 in. for 4¾ mi. to Volunteer Park reservoir; 42 in. for 5 mi. to Maple Leaf reservoir.

Governing twin factors in the program for carrying out the improvements are the present wood-stave pipe lines and the need for storage, both nearer and within the city. (See *Engineering News*, Jan. 20 and 27, Feb. 3, Mar. 30, Apr. 6, 1915, pp. 140, 184, 197, 233, 585, 647.)

No. 1 wood-stave pipe line is now being reconstructed and No. 2 will soon need to be. The report states that if the city had the courage to rebuild the wood pipe lines every 12 years "we could probably obtain as satisfactory results as to safety of operation with wood pipe as with steel, and at very much reduced cost." But in view of the "tendency of human nature to put off reconstruction" as long as the old lines hold out steel rather than wood is recommended for the lower portion of the new conduit.

Water storage for Seattle, with a present estimated population of 300,000, and a maximum water consumption of 42,000,000 gal. a day, is limited to 183,000,000 gal. for the low service, 83,000,000 for the intermediate service, and practically nothing for the high service. The demand on the low service is greater than that on the high service but not in proportion to the storage. The two conduits together have a capacity of 63,000,000 gal. a day.

The two wood-stave pipe conduits pass close by Swan Lake, at a point about one third the distance from the intake to the city. This lake has a drainage area of perhaps 3,000 acres, and a water area of 535 acres. The city owns 23,000 of the 32,000 lin.ft. of shore line and 288 sq.mi. of the drainage area of the lake. A dam 16 ft. high would give 4,410,000,000 gal. available storage in the lake, or 100 days' summer and 200 days' winter consumption at the present rate. Such storage would reduce the pipe line hazard by a third, postpone the necessity for a more permanent pipe line between the intake and the lake, and give the supply the well known benefits due to storage.

If the two existing conduits were to discharge into Swan Lake their delivery capacity up to that point would be increased from 63,000,000 to 80,000,000 gal. a day. When still more capacity is needed, a 150,000,000-gal. concrete conduit should be built. Estimates show that for governing conditions plain concrete would be cheaper than reinforced concrete. This conduit would discharge into the east end of the lake. The outtake would be at the north end, and for about 2½ mi., or to Molasses Creek, local conditions favor a concrete conduit.

The capacities of the lower portion of the existing conduits would be reduced by the Swan Lake connection to 52,000,000 gal. a day, so when the connection is made

a 50,000,000-gal. conduit should be built the remaining distance to the city.

The most imperative need today is more storage in the city. The report recommends that the city reservoir capacity be greatly increased and that some of this increase be made second to nothing but the completion of the rebuilding of Pipe Line No. 1, now in progress.

The estimated cost of the entire program recommended is as follows:

Concrete Conduit, Landsberg to Swan Lake, including rebuilding of intake	$573,000
Development of Swan Lake, including aqueduct to Molasses Creek	777,000
Replacing No. 1 Line with steel*	625,000
Replacing No. 2 Line with steel*	1,180,000
Steel Pipe Line No. 3, Molasses Creek to West Seattle	1,650,000
Steel Pipe Line No. 4, Molasses Creek to Volunteer Park	1,600,000
Enlarging Volunteer Park Reservoir	190,000
Enlarging Lincoln Park Reservoir	70,000
Reservoirs at West Seattle	483,000
Distribution	1,034,000
Total	$8,182,000

*Evidently meaning from the end of the concrete conduit only; if rebuilt of wood instead of steel the cost for the two would be reduced about $1,000,000.

If in place of a concrete aqueduct, Conduits 1 and 2 were rebuilt of steel and new Conduits 3 and 4 were also built of steel, each when needed and for the entire distance from the intake of the city, and Swan Lake was cut out of the program, the total cost would be $10,127,000 or $7,727,000 if Nos. 1 and 2 were rebuilt of wood instead of steel.

The successive steps recommended in the report are as follows:

1. Complete the rebuilding of Pipe Line No. 1 in wood.
2. Increase the capacity of Volunteer Park Reservoir.
3. Acquire and develop Swan Lake, including necessary lands and rights-of-way.
4. Build Pipe Line No. 3 of steel, from Molasses Creek to West Seattle.
5. Acquire sites and construct the West Seattle reservoirs.
6. Construct new distribution mains.
7. Rebuild Pipe Line No. 2 in wood or steel, as experience may dictate.
8. Construct a single conduit from Landsberg to Swan Lake, when necessary because of the need of additional supply or because of failure of present pipe lines.
9. Construct Pipe Line No. 4 from Swan Lake to Volunteer Park.

This would give 150,000,000 gal. a day. Items 2 to 7 (No. 1 already in progress) call for an outlay of $4,205,000. This should be authorized at once, the report says, but would be distributed through three to five years.

Portland Cement Specifications

As outlined in the report of the annual meeting of the American Society for Testing Materials on another page, a new specification for portland cement was adopted by that meeting with the prospect of similiar adoption by the letter ballot of the Society, the U. S. Government departmental cement committee, the American Society of Civil Engineers and many minor societies. This specification, then, will probably be as nearly as possible a nationally accepted standard. Below is given that part of the specifications relating to requirements; there are in addition 33 sections relating to the methods of testing. The new specification is entirely rewritten and rearranged and does not include the requirements for natural cement. The main differences between it and the old A. S. T. M. standard specifications are as follows:

Fineness has been increased from 75% to 78% through a 200-mesh screen, with no prescription for the 100-mesh screen in the new specification. The permissible SO_3 content has been increased from 1.75% to 2% and the MgO content from 4% to 5%. The time of initial set has been increased from 30 min. to 45 min. as read on the Vicat needle and an alternate permission to use the Gillmore needle has been included. The neat test for tensile strength has been omitted and the 28-day tensile requirement for 1:3 mortar briquettes has been increased from 275 lb. per sq.in. to 300 lb. per sq.in. The normal air and cold-water tests for soundness have been eliminated and only the steam test retained.

The first 15 clauses of the specifications follow:

1. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

I. CHEMICAL PROPERTIES

2. The following limits shall not be exceeded:

Loss on ignition, per cent	4.00
Insoluble residue, per cent	0.85
Sulphuric anhydride (SO_3), per cent	2.00
Magnesia (MgO), per cent	5.00

II. PHYSICAL PROPERTIES AND TESTS

3. The specific gravity of cement shall be not less than 3.10 (3.07 for white portland). Should the test of cement as received fall below this requirement, a second test may be made upon an ignited sample. The specific gravity test will not be made unless specifically ordered.

4. The residue on a standard No. 200 sieve shall not exceed 22% by weight.

5. A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking or disintegration in the steam test for soundness.

6. The cement shall not develop initial set in less than 45 min. when the Vicat needle is used or 60 min. when the Gillmore needle is used. Final set shall be attained within 10 hr.

7. The average tensile strength in pounds per square inch of not less than three standard mortar briquettes (see Par. 57), composed of one part cement to three parts standard sand, by weight, shall be equal to or higher than the following:

Age at Test, Days	Storage of Test Pieces	Tensile Strength, Lb. per Sq.In.
7	1 day in moist air, 6 days in water	200
28	1 day in moist air, 27 days in water	300

8. The tensile average strength of standard mortar at the age of 28 days shall be higher than the strength at 7 days.

III. PACKAGES, MARKING AND STORAGE

9. The cement shall be delivered in suitable bags or barrels with the brand and name of the manufacturer plainly marked thereon, unless shipped in bulk. A bag shall contain 94 lb. net. A barrel shall contain 376 lb. net.

10. The cement shall be stored in such a manner as to permit easy access for proper inspection and indentification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

IV. INSPECTION

11. Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified. At least 10 days from the time of sampling shall be allowed for the completion of the 7-day test, and at least 31 days for the 28-day test. The cement shall be tested in accordance with the methods hereinafter prescribed. The 28-day test shall be waived only when specifically ordered.

V. REJECTION

12. The cement may be rejected if it fails to meet any of the requirements of these specifications.

13. Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

14. Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

15. Packages varying more than 5% from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

News of the Engineering World

Thacher Bridge Patent Called Invalid by District Court

The well-known United States Patent No. 617,615 issued to Edwin Thacher, Jan. 10, 1899, for a "new and useful improvement in concrete arches" has been declared invalid by Judge Hale of the United States District Court, District of Maine, in a decision handed down June 27, 1916, in the case of Edwin Thacher vs. the Inhabitants of the Town of Falmouth. The judge based his decision mainly on the contention of counsel that the Monier arch, as shown in the celebrated 1895 arch experiments of the Austrian Society of Engineers and Architects, is a substantial anticipation of the Thacher claims. Other patents apparently did not enter into the defense of the case.

The bridge in question is a 160-ft. twin-rib reinforced-concrete arch, the ribs being reinforced with upper and lower rows of ¾-in. rods tied together every 3 ft. with so-called "hoops" of ½-in. rods and vertical so-called "binders" of ⅜-in. rods. In contradistinction to one Thacher suit, however, these vertical rods were not brought into the case to set up the dependence of the upper and lower longitudinal rods. The suit was for infringement of the first and third claims of the patent; it was brought by Mr. Thacher against the town but it was defended by the Maine State Highway Commission, with S. W. Bates, of Portland, Me., as attorney.

As stated, the main defense was the 75-ft. Monier bridge tested by the Austrian society and described in the *Zeitschrift des Oester. Ingenieur- und Architekten-Vereines*, under date of May 24 and May 31, 1895. The judge's comments on this bridge are as follows:

It is in evidence that in 1895 the "Zeitschrift" of the Austrian Society of Engineers and Architects published in a supplement the results of a series of tests made on full-sized arch bridges of certain well-known types, for the purpose of getting data for calculations. Among other publications was the description of a bridge 75 ft. long, built on the Monier plan, with longitudinal wires about ½ in. in diameter and cross-wires about ½ in. in diameter. The proofs contain also cuts and descriptions of the bridge construction. This publication is shown to have been made some time before the application for this patent was filed.

I think the "Zeitschrift" must be held to disclose a construction having in combination all the elements of the patent in suit. It contains the abutments, the concrete arch, the series of pairs of bars, one bar of each pair near the intrados, and the other pair near the extrados; it shows each bar extending well into the abutments, after the completion of the abut ments. I think there can be no doubt that the concrete work, into which the arch extends, must be held to be a part of the abutment after the construction is complete. Each bar of the pair is clearly independent of the other bar of the pair. It appears that the wires in use, under the system disclosed in this publication, were ½ in. in diameter. A wire of this character may well be called a bar; the reinforcement used in the construction described in the publication was something more than a wire netting.

We have before us the drawing of the Thacher patent; also of the defendant's construction. Having these two drawings in mind, if we examine the drawing described by the "Zeitschrift" publication, we shall see that this drawing appears to present the elements of the Thacher patent and of the defendant's construction, as I have just referred to them in detail.

The Court further ruled that the publication in the foreign periodical was legal anticipation and that the fact that the bridge was for test and not for practical use could not be used to eliminate it. The decision continues:

The "Zeitschrift" device appears to belong to the German Monier system. It is not necessary, however, to decide to what system it belongs. In my opinion it discloses public knowledge of the improvement in question. In view of this disclosure, the proofs lead me to believe that the complainant did not discover anything new. He enlarged some of the longitudinal wires; he omitted some of the lateral wires; he made some other mechanical changes; by these means he thought he would be enabled to build a bridge more economically than it could be built under the Monier system. The result is shown in what the complainant has brought before the public.

He testifies that he had read a paper produced by Frederick von Emperger before the American Society of Civil Engineers, giving a sketch of the Monier system. This was some time before von Emperger produced his patent No. 583,464 in 1897 to which reference has been made by the courts. The complainant testified that this paper started him upon the line of inventive thought which led up to this patent. The proofs do not induce the belief, however, that Mr. Thacher made any advance in the art.

Variations of size of wires do not constitute invention; widening the spaces between the bars, to enable an engineer to use coarser concrete, is not invention; dispensing in whole or in part with unessential parts is not invention; producing economy in bridge building by consolidating numerous small bars into one large bar cannot be said to be invention. These things are mechanical; they relate to good engineering; they do not disclose inventive thought.

The judge then sought to show that had the Austrian bridge been submitted to the court in the two previous Thacher cases (Maryland: *Engineering News*, Mar. 4, 1915, p. 461; Feb. 10, 1916, p. 290. New York: *Engineering News*, Mar. 23, 1916, p. 580; June 15, 1916, p. 1157) it would have come under what the judges in these cases considered an anticipation.

The final decision is as follows:

After a careful examination of the "Zeitschrift" publication I am constrained to hold that Mr. Thacher's alleged invention in the patent in suit was described in a printed publication previous to his application for a patent, and that such printed publication was made in this country and in a foreign country. By reason of this publication I find that the patent in suit does not disclose invention; it is therefore invalid.

Having taken this view of the publication to which I have referred, it is not necessary to refer to other publications, although other publications are produced illustrating the German Monier system.

In view of my conclusion as to the validity of the patent, it is not necessary to discuss the question of infringement. The bill of complaint is dismissed with costs.

Boston Tunnel Face Blows Out

A statement concerning the Boston Edison tunnel blowout, June 24, 1916, indicates the remarkable fact that a tunnel face of practically semiliquid material blew out with such violence that nearly the full height of the shaft was filled with the inflowing mud and water. The tunnel is being built as a cable conduit under the Reserved Channel at what is known as the L Street Bridge on Summer St. Extension in South Boston. It is to be a 7-ft. circular tube 70 ft. below street surface and 984 ft. long between end shafts. The tunnel walls

are 12 in. thick, the shaft walls 16 in. thick; the shafts are also 7 ft. in diameter inside.

Borings showed under the harbor silt coarse sand and gravel, silt and sand, stiff blue clay, and finally a hard stratum of sand, gravel and clay. In the latter the tunnel was located.

Work was begun at the west shaft, which was sunk to depth as a steel caisson under compressed air. Excavation for the tunnel away from the shaft had just started at the time of the accident. A pressure of 30 lb. was being carried, indicating that the face was not as good as the borings had indicated.

Four men had just entered the heading. They were carried out with the blowout, and their bodies have not been recovered. The inflow nearly filled the shaft.

The Boston Edison company declined to give information on the accident. Investigation by the public authorities may throw more light on the facts. The Hugh Nawn Contracting Co. is constructing the tunnel.

Tunnel Will Not Be Built

The Supreme Court of the State of Pennsylvania on July 1 declared unconstitutional the act under which the so-called Neeld or South Hills tunnel, Pittsburgh, was to be built by the county. The decision reversed the Common Pleas Court of Allegheny County and the Superior Court. It involves both a defective title and the general proposal to have the county construct works within the city. Contract for the tunnel was let last fall to Booth & Flinn. Work was started on a sewer diversion near the west end of the tunnel, this diversion itself being a piece of tunnel work in shale. About $50,000 worth of work has been done. The whole enterprise was to cost about $1,350,000. A section and profile with data were printed in *Engineering News* of Aug. 12, 1915, p. 300.

Boston Engineers Reinstated in City Service by Court

A legal decision of interest to all engineers and of special interest to engineers in Boston was filed in the Dorchester District Court on June 27 by Judge Joseph R. Churchill. This decision orders the reinstatement of Frank A. McInnes, division engineer in charge of the sewer and water service, Storrs L. Durkee, superintendent of the permit department of the paving division, and Bliss W. Robinson, superintendent of the main drainage system, who, of the 17 employees of the Public Works Department discharged last January, contested the action of the mayor in announcing that their positions were abolished.

A few days after their "discharge" a hearing was given to these three men by the Commissioner of Public Works, Edward F. Murphy, as provided under the civil service regulations. The commissioner maintained that he had no complaint as to their efficiency, but that the department had been reorganized and the positions abolished so that there was no further occasion for their services.

The attorney for these men, Arthur D. Hill, decided to carry the cases on. Much testimony was presented to show that the so-called reorganization of the Public Works Department had been made in bad faith and that the work of the city could not actually be carried on without filling the vacant places, even though under different titles. The city, through its law department, attempted to show that the service had not been injured and that the civil service regulations had not been violated because the positions had not been filled. The case attracted much attention, because it is the first that has ever been brought under this law. Among the witnesses who were introduced for the plaintiffs were L. K. Rourke, consulting engineer, formerly Commissioner of Public Works; Frederick H. Fay, consulting engineer, formerly division engineer of the bridge and ferry division of the Public Works Department; Guy C. Emerson, consulting engineer of the Boston Finance Commission and a former superintendent of streets; Frederic P. Stearns, consulting engineer and past president of the American Society of Civil Engineers, and others.

The evidence was well summed up in Mr. Hill's argument, in which he said:

> We are required to prove that the petitioners held positions under civil service rules. That is conceded. We are required to prove that the petitioners were removed from positions or reduced in rank or salary without proper cause, or in bad faith. If we show they were removed without proper cause, we have shown enough, without regard to the proposition of bad faith. But I think in this case the matter of bad faith is proved. The question is whether the abolition of the offices was a bona fide abolition. If Mr. Murphy removed these men for any other reason than to maintain the proper working of the department he did it in bad faith. It is on this issue that the whole matter hangs. Mr. Murphy was given wide liberty under the Boston city charter. All he had to do was to act in good faith. But, if we show he acted otherwise than in good faith in the fullest sense of the word, then we have proved our cases. These offices could not be abolished in the true sense of the word.
>
> There is no charge of inefficiency against any of the petitioners. . . . . But Mr. Murphy hit upon the term "lack of effective coördination" as a substitute for "inefficiency."
>
> I think the charts will show that there was no real reorganization. . . . . It was shown that the new plan could be devised only for an ulterior motive and that it is full of inefficiencies and conflict of authority as well as overloading.

Judge Churchill concluded his opinion ordering the men to be reinstated with the following words:

> It follows from my findings that the order of removal was made by the respondent without proper cause and in bad faith and the order must be reversed in each case and the three petitioners be reinstated to their offices.

North River Piers Completed Inside Huge Coffer-Dam

The great coffer-dam at West 46th St., New York City, built in connection with the construction of the new 1,000-ft. pier, was flooded on the afternoon of June 29. To witness the opening of the sluice gates by Mayor Mitchel, a large party of invited guests and engineers were taken to the work by R. A. C. Smith, Commissioner of Docks, and C. W. Staniford, Chief Engineer. The coffer-dam was described in *Engineering News* of July 23, 1914. It is much larger than any previous dam of this type ever built. The only two important dams of a similar type are those built at Black Rock, near Buffalo, and one at Troy. In these previous dams the piles were less than 50 ft. in length and were driven through hard river bottom. At the West 46th St. coffer-dam the river bottom is of solid rock overlain with a thick layer of very soft silt. To make the successive cylinders which made up the dam at West 46th St., Lackawanna steel sheetpiles 70 ft. in length were driven and the contact of the sheetpiling in the interlock was

the main reliance for watertightness. The bursting pressure on the interior of the cylinders was relieved by dumping riprap on either side of them. The coffer-dam proper was water-tight and remained so during the fifteen months from its completion until water was again admitted. The only places where water entered were through springs on the land side and a single leak at the 44th St. corner of the dam, where two piles encountered a boulder and could not be driven to the bottom.

The water pressure against the dam was about 90 tons per lineal foot. The dam contains about 3,800 tons of steel piling and about 90,000 cu.yd. of riprap. The area inclosed by the dam was about 5½ acres.

Rienach-Wurl Screens and Activated-Sludge Tanks have been recommended to treat the sewage of Lima, Ohio, by Geo. W. Fuller, Consulting Engineer, New York City. The plan is to operate the screens the year round, but at the outset to run the activated-sludge tanks about seven months in the year, when the flow of the Ottawa River is relatively small.

An Iron-Removal and Water-Softening Plant will be added to the water-works of Lawrence, Kan., the distribution system extended and protection against floods provided at a cost of $200,000. This work was projected some time ago, but was delayed until a second election, to make good a technical defect in the first one, could be held on buying the privately-owned plant. A favorable vote was secured on June 22.

Comparative Registrations at the second day of the meetings of the American Society of Civil Engineers at Pittsburgh and the American Society for Testing Materials at Atlantic City, both from June 27 to 30, are as follows: Am. Soc. C. E., Pittsburgh men 130, out-of-town men 132 (total 262), ladies 156. Am. Soc. T. M.; men 502, ladies 130. The latter society registered about a dozen more in the later days of the meeting; records for these days a the Pittsburgh meeting are not available.

Cement Production in 1915, as now finally reported by E. F. Burchard, of the United States Geological Survey, was practically the same as predicted in the preliminary report ("Engineering News," Jan. 27, 1916, p. 193). The shipments of natural cement in 1915 were 750,863 bbl., valued at $358,627, a decrease in quantity of 422 bbl., and an increase in value of $7,257 compared with those of 1914. The shipments of puzzolan cement in 1915 were 42,678 bbl., valued at $39,801, a decrease in quantity of 25,633 bbl. and in value of $23,557 compared with the shipments of 1914. The shipments of portland cement in 1915 were 86,891,681 bbl., as against 86,437,956 bbl. in 1914. Portland cement production in 1915 was only 85,914,907 bbl. against 88,230,170 bbl. in 1914. The 1915 average price per bbl. at factory was $0.86 against $0.927 in 1914.

The Increase in City Debt is the subject of a bulletin issued by the Census Bureau on July 7. The statistics cover 204 American cities which have a population of over 30,000. In 156 of these cities the net increase in debt during the fiscal year 1915 was $147,000,000, or $5.48 per capita of population. In the remaining 48 cities the debts were reduced during the year, the revenue exceeding the expenditure. The total reduction, however, was only $7,700,000. The debt conditions of the smaller cities are nearly hidden, however, by the overwhelming preponderance of the three largest cities—New York, Chicago and Philadelphia. The net indebtedness of New York City alone ($921,754,000) is nearly two-thirds as much as the total debt of all other cities of over 30,000 population taken together. The net per capita indebtedness of New York City amounts to $172.82.

PERSONALS

Roy O. Walker has resigned as City Engineer of Tarpon Springs, Fla.

R. S. Sinclair has resigned as President of Alsen's American Portland Cement Works, New York City.

Wm. P. Corbett has been appointed First Vice-President of Alsen's American Portland Cement Works, New York City.

Charles P. Jaegar, recently Deputy Commissioner of the Cleveland (Ohio) water-works department, has been appointed Commissioner.

J. W. Kittrell, M. Am. Soc. C. E., of Rochester, N. Y., has been appointed General Manager of Alsen's American Portland Cement Works, New York City.

J. A. Wade, formerly with the S. Morgan-Smith Co., York, Penn., is now with George F. Hardy, M. Am. Soc. C. E., Consulting Engineer, New York City.

George W. Fuller, M. Am. Soc. C. E., has been appointed Special Lecturer on Sanitary Engineering (sewage disposal) at Sheffield Scientific School, Yale University.

M. E. Ready, former Assistant Engineer of the United States Reclamation Service, is now with engineering department of the Chicago, Milwaukee & St. Paul Ry., at Chicago.

J. L. Parsons, drainage and civil engineer, has resigned his position with the Lehigh Sewer Pipe and Tile Co., and has again taken up private practice, with offices at Fort Dodge, Iowa.

Charles R. Gow, M. Am. Soc, C. E., a well known engineer and contractor of Boston, Mass., has resigned from the Boston Licensing Board, to which he was appointed by Governor Walsh.

H. R. Hershey, recently Chief of Construction, Pennsylvania State Highway Department at Allentown, has been promoted to be Road Superintendent of Lehigh and Northampton Counties.

George H. Graves, formerly Assistant Electrical Engineer of the Sanitary District of Chicago, is now head of the department, having succeeded Edward B. Ellicott, M. Am. Inst. E. E., resigned.

Jerome Newman, M. Am. Soc. C. E., Chief Engineer of the Board of State Harbor Commissioners, San Francisco, Calif., has resigned, owing to differences with the President of the Board, J. J. Dwyer.

Arthur B. Morrill has accepted a position with Morris Knowles, Civil Engineer, of Pittsburgh, Penn. Mr. Morrill was formerly employed at the sewage disposal plant of the Baltimore Sewerage Commission.

Herman Nieter, former Sales Manager of the Kennicott Co., at Chicago, and later Manager of the New York office of the Blaw Steel Construction Co., is now Sales Engineer of the American Spray Co., New York City.

C. A. Case, Assoc. M. Am. Soc. C. E., formerly with the St. Louis & San Francisco Ry., at Joplin, Mo., and later with Albert C. Moore, Consulting Engineer, Joplin, Mo., has been appointed City Engineer at Neodesha, Kan.

C. D. Emmons, General Manager of the Chicago, South Bend & Northern Indiana Railway Co., South Bend, Ind., has resigned to become Vice-President and General Manager of the Boston & Worcester Street Ry., Boston, Mass.

Charles W. Lusk, Assoc, M. Am. Soc. C. E., for the last six years Designing Engineer with Burns & McDonnell, Consulting Engineers, Kansas City, Mo., has been appointed City Engineer of Arkansas City, Kan., succeeding J. K. Titus.

Louis N. McDonald, recently Superintendent of the open-hearth and bessemer departments of the Ohio Works of the Carnegie Steel Co., Youngstown, Ohio, has been promoted to be Assistant General Superintendent of the Youngstown district of the company.

Frank B. Black, of Garrett, Somerset County, a member of the Pennsylvania State Commission of Agriculture, was appointed State Highway Commissioner, July 1, by Governor Brumbaugh. He succeeds the late Robert J. Cunningham, who died at Sewickley, April 4.

Ernest Martin Hopkins, of the American Bell Telephone Co., Boston, Mass., has been elected President of Dartmouth College, to succeed Ernest Fox Nichols, resigned. Mr. Hopkins is a graduate of Dartmouth and was formerly private secretary to President Tucker of the college.

Walter D. Hines, Chairman of the Executive Committee of the Atchison, Topeka & Santa Fe Ry., has been elected to the newly created office of Chairman of the Board of Directors. Mr. Hines is also General Counsel of the railway and will hereafter devote his whole time to the company.

A. R. Murphy, Jun. Am. Soc. C. E., of Knoxville, Tenn., has become associated with the engineering staff of Wallace & Tiernan Co., manufacturers of chlorine control apparatus, New York City. Mr. Murphy is a graduate of the University of Tennessee and has had several years water-works experience.

C. L. Sturdevant, Captain, Corps of Engineers, U. S. A., has been transferred from the Pittsburgh Office to Montgomery, Ala., where he will take charge of the office there, relieving Maj. F. C. Boggs. Major Boggs, who was formerly General Purchasing Agent of the Isthmian Canal Commission, has gone to the border.

Edgar Jadwin, Lieutenant-Colonel, Corps of Engineers, U. S. A., took charge of the Pittsburgh office on July 1, relieving

Col. Francis R. Shunk. Col. Jadwin has just completed a trip over the rivers in the territory in charge of the Pittsburgh Engineer Office, inspecting the slackwater improvements completed and under way.

James F. Barker, Principal of the East Technical High School, Cleveland, Ohio, has resigned to become President of Mechanics Institute, Rochester, N. Y., at a salary of $4,500 per annum. He graduated from Cornell University in 1893 and for a time was with the designing department of the Allis-Chalmers Co. at Milwaukee, Wis.

Richardson & Hale, Civil Engineers, Boston, Mass., are temporarily out of business because of the sending of the Massachusetts militia to the Texas border. Maj. Richard K. Hale, Assoc. M. Am. Soc. C. E., commands the First Battalion of Field Artillery, and Capt. Edward B. Richardson is in command of Battery A of the same battalion.

William C. Bulmer, former Special Engineer of bessemer department of the Ohio Works of the Carnegie Steel Co., Youngstown, Ohio, and recently Assistant Superintendent of the openhearth and bessemer departments, has been promoted to be Superintendent of these departments, succeeding Louis N. McDonald, promoted as noted elsewhere. Mr. Bulmer is a graduate of the University of Michigan, class of 1909.

Edward E. Krauss, formerly Secretary of the American Concrete Institute, **S. D. Burrows,** and **Frederick Edinger,** formerly Engineer in charge of design and construction with Wayss & Freytag, of Dusseldorf, Germany, have formed the Integrity Construction Co., with offices at 612 Lincoln Bldg., Philadelphia, Penn. The firm will engage in general contracting and engineering work, specializing in reinforced concrete.

Samuel Hill, Past-President of the American Road Builders' Association, of Seattle, Wash., is reported to have gone to Vladivostok, Siberia, to take charge of the traffic department of the Trans-Siberian Ry. for the Russian Government. Mr. Hill is a lawyer by education. He is a son-in-law of the late J. J. Hill, of St. Paul, and his early experience was as counsel of the St. Paul & Northern Pacific Ry. and the Minneapolis & St. Louis Ry. He has also served as President of some of the Great Northern subsidiary lines.

J. B. Ambler, Assoc. Am. Inst. E. E., **O. W. Ott** and **L. J. Riter,** have formed the firm of Ambler, Ott & Riter, Consulting Engineers, Kearns Bldg., Salt Lake City, Utah. Mr. Ambler is a graduate of the University of Pennsylvania and was formerly connected with the engineering department of the General Electric Co. and was recently Sales Engineer of the Salt Lake district; Mr. Ott is a graduate of Cornell University and was recently a member of the firm of Wilson & Ott, Consulting Engineers, previous to which he was Mechanical Engineer of the Oregon Short Line R.R.; Mr. Riter is also a graduate of Cornell University and has been with the Utah Power and Light Co., the Nevada Consolidated Mining Co., and other railway and mining corporations.

OBITUARY

Joseph O. Osgood, M. Am. Soc. C. E., Chief Engineer of the Central R.R. of New Jersey, died June 28 from heart disease at the Broad St. station of the railway in Newark, N. J. A portrait and biography will be published in next week's issue.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenberg, Myers Building, Bethlehem. Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

THE ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The Engineer's Society of Western Pennsylvania entertained the members of the American Society of Civil Engineers at the Pittsburgh Convention, at a successful smoker on June 30. About 500 members and guests were present on the floor, while the balconies were filled with ladies attending the convention.

The Illinois Association for Public Health and Welfare has been organized to promote this field of activity throughout the state. The honorary president is Dr. Robinson (President of the State Board of Health); president, Dr. G. T. Palmer; secretary Paul Hansen (Chief Engineer of the State Board of Health, Springfield, Ill.)

The Kansas State Drainage and Conservation Association was organized in Topeka, Kan. June 22, with the following officers: President, V. R. Parkhurst, secretary, C. B. Zarker, Topeka; vice-presidents, C. P. Humphreys, H. E. Dean, D. L. Dawdy, R. T. Wright, M. W. Crum, O. O. Wolf, O. E. Noble, James Shimer, S. W. Knotts and George Plum. The association will request the legislature to increase the authority of drainage boards, to provide for surveys of new drainage districts and to give the drainage boards power to condemn property for flood protection.

The National Exposition of Chemical Industries will take place for the second time in New York City in the week of Sept. 25, under the management of the International Exposition Co., at the Grand Central Palace. The American Electrochemical Society has arranged to hold its annual meeting Sept. 28 to 30. In this week the Technical Association of the American Pulp and Paper Industries expects to hold an annual meeting. The membership of this association comprises chemists, engineers, plant superintendents and foremen engaged in the manufacture of paper and its byproducts. The Bureau of Commercial Economics, Washington, D. C., is coöperating with the Exposition by arranging an elaborate program of motion pictures covering subjects dealing with the industries depending on chemistry.

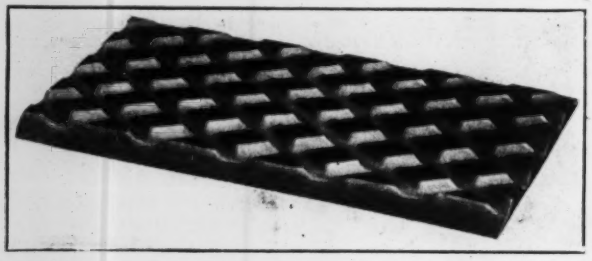
The Roadmasters and Maintenance-of-Way Association will hold its annual convention Sept. 19 to 22, in New York City, at the Hotel McAlpin. The Entertainment Committee held a meeting on June 17, and at that time outlined the general program. The first day will be devoted to routine business and to discussion of committee reports, the latter being continued on Wednesday morning. On Wednesday afternoon, Sept. 20, there will be an inspection trip to the western end of the Long Island R.R., the party returning in time for a business session in the evening. The next afternoon a special train will conduct the members and guests over the main line of the New York, New Haven & Hartford R.R., between Grand Central Terminal and Stamford, Conn., while in the evening the Track Supply Association will give a banquet to the members and a theater party for the ladies. Friday morning will be devoted to business, and to an inspection of the exhibits of the supply association. In the afternoon the Central R.R. of New Jersey will carry a party down the Hudson River, through New York Harbor to Sandy Hook and Atlantic Highlands, thence by train to Asbury Park, and returning to New York. The secretary is L. C. Ryan, C. & N. W. Ry., Sterling, Ill.

Appliances and Materials

A New Safety Tread

A new type of safety tread was recently placed on the market by the American Mason Safety Tread Co., Lowell, Mass. The "Black Diamond" tread (the trade name of the new type), like the original Mason tread, meets the recognized requirements of a non-slip stair tread, including the deformed surface for receiving foreign substances, such as match stems, snow, ice, etc., and the necessary open-end grooves for drainage and easy cleaning.

The abrasive material is carried entirely through the tread. The tread is made up of a skeleton metal frame, the surface of which presents a series of raised diamond-shaped openings. Each diamond unit is thus surrounded by a steel



BITUMINOUS SAFETY TREAD

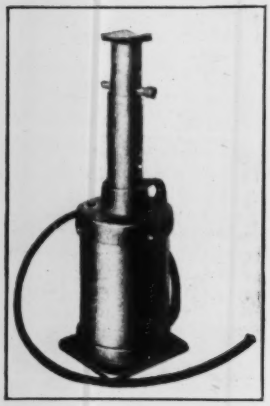
frame which takes the wear, the abrasive wearing down in proportion to the wear on the steel frame. The base of the tread consists of asphaltic compound.

Mason treads can be applied to all types of stairs, whether wood, marble, concrete or steel. When ordered for new concrete work the treads are shipped with anchors attached, ready to put in place.

* * *

Pneumatic Lifting Jack for General Service

The small lifting jack shown is built by the Baird Pneumatic Tool Co., Topeka, Kan., for the various small jobs that occur around shop or yard. It has a minimum height of 10½ in. and with piston extended is 16 in. high. It may be operated by an ordinary automobile tire pump or from shop air connections. A central telescoping piece can be raised 2 in., making the total height 18 in. For the sake of additional safety holes are drilled crosswise through the piston and the telescoping piece, so that the latter may be locked with a pin when raised. The jack weighs 10½ lb.



PNEUMATIC LIFTING JACK

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Improved Tracing Cloth

A new and improved tracing cloth, bearing the trade name "Stirling," is being imported by the Defiance Manufacturing Co., 22 East 42nd St., New York City, the company being exclusive sales agents. After long research the makers developed for the fabric a coating that requires the use of no powder on the cloth before inking. The cloth is claimed to be 30% more transparent than the market standard, and tests have shown that up to six erasures may be made before re-inking is impossible. The price is about 10% under that of the standard cloths. It is reported that the British Indian Government has used 22,000 rolls in a year.

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Ingersoll-Rand to Make Condensing Plants

The Ingersoll-Rand Co., 11 Broadway, New York City, is offering complete steam-condensing plants for all services. The equipment includes the "Beyer" barometric condenser, for which the company has secured the patent rights, "Imperial" duplex and "Ingersoll-Rogler" straight-line reciprocating dry vacuum pumps and, where required, "Cameron" simplex and centrifugal pumps.

The "Beyer" barometric condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above and the air-removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle-plates. The non-condensable air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water and removed before it mixes with the steam.

The hot waste water is discharged through the self-draining tail pipe. This pipe straddles the hot well and rigidly supports the condenser. The vacuum and water pumps are independently operated and regulated to meet varying water temperatures.

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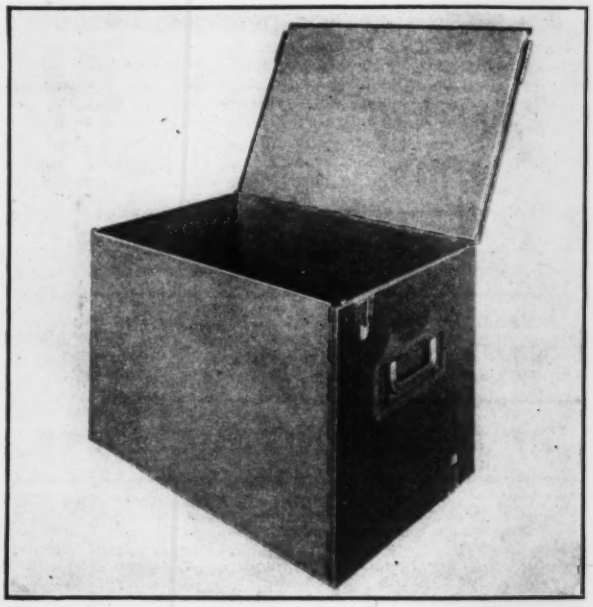
Collapsible Steel Freight Container

A steel container for package freight has been placed on the market by the Pneumatic Steel Corporation of Norfolk Downs, Mass. The material of which the sides are made is formed of three thin steel sheets, with the two outside ones sweated on the middle sheet, which is corrugated. Protected hinges run the entire length of the ends and sides, enabling it to be knocked down to a thickness of ¾ in. There is a locking device and each shipper or owner can be provided with a private lock if desired. The handles are flush with the ends, and space is provided in the handle recesses for placing shipping instructions. The box can be manufactured in any desired size. Its first cost is high when compared with wooden boxes, but its strength and convenience make it worth considering in many instances.

The strength of this box was recently demonstrated in the testing laboratory of the Massachusetts Institute of Technology. For comparative purposes a standard wooden box used by the American Sugar Refining Co., made of ⅜-in. hemlock with ⅞-in. pine cleats 2 in. wide around the edges, was selected to be tested equally with a steel box of the same inside dimensions, 13⅞x19⅞x14⅜ in. The weight of the



COLLAPSIBLE STEEL FREIGHT CONTAINER

wooden box was 11.5 lb., and of the steel box 21.2 lb. The boxes were filled with 120 lb. of sugar in 60 two-pound cartons.

When pressure was applied at the diagonally opposite corners, the steel box proved to be ten times as strong as the wooden box. When filled with sugar and dropped 3 ft. upon a concrete foundation two times, the wooden box was demolished and the contents badly damaged on the first test, while the steel box showed only slight injury at the corner and none of the pasteboard cartons was injured after the second test. Further tests still further proved the excellence of the steel container.